Rhodium Carbenoid Mediated Cyclisations. Part 4.[1] Synthetic Approaches to Oxepanes related to Zoapatanol

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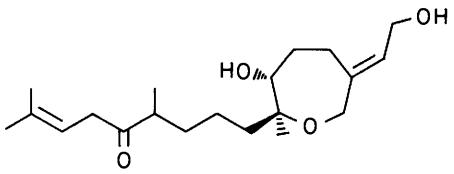
Synthetic approaches to the oxepane diterpene zoapatanol are described, in which the key step is the formation of the 7-membered cyclic ether by a rhodium carbenoid cyclisation. The model oxepane (**15**) was synthesised from (*E*)-geraniol by selective epoxidation of the allylic alcohol, followed by conversion into the corresponding epoxy iodide (**9**). Reaction of the iodide with the anion of ethyl acetate gave, after opening of the epoxide, diazo-transfer and acetylation, the substrate (**14**) for cyclisation. Treatment of (**14**) with rhodium(II) acetate resulted in cyclisation to the required oxepane (**15**) in good yield (Scheme 3). The approaches to the functionalised side chain of zoapatanol centred on the allylic alcohols (**25**), prepared by allylic oxidation of geraniol and functional group transformation. After asymmetric epoxidation, these substrates were converted into the diazo alcohols (**30**) using a similar sequence to above (Scheme 5). Finally, cyclisation using rhodium(II) acetate gave the unstable optically active oxepanes (**31**), which were characterised by conversion into the silyl enol ethers (**32**).

The diterpene zoapatanol (**1**), isolated from the Mexican zoapatle plant, *Montanoa tomentosa*, has generated much interested over the last decade because of its reported anti-fertility properties.[2] The structure of zoapatanol was elucidated in 1979,[3] and since then five syntheses have been published,[4–8] together with the syntheses of many analogues.[9] However, with the exception of one extremely lengthy synthesis,[6] all the other routes rely on forming the substituted oxepane system by ring opening a suitable epoxide with an oxygen nucleophile.



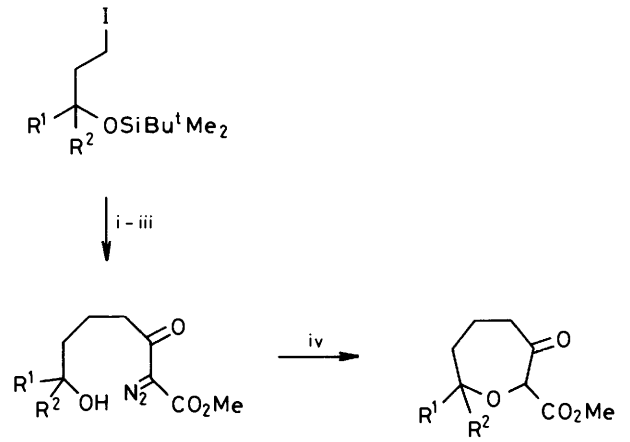
(**1**)

We have recently described a new route to 3-oxo-oxepanes based on the rhodium carbenoid mediated cyclisation of ω-hydroxy-α-diazo-β-keto esters, readily prepared from protected iodo alcohols and the dianion of methyl acetoacetate, followed by diazo-transfer and deprotection (Scheme 1),[10] and we now report a synthetic approach to zoapatanol based on this method.

Results and Discussion

By analogy with the above route to simple 3-oxo-oxepanes, it seemed likely that the 3-oxo-oxepane (**2**), a possible precursor to zoapatanol (**1**), could be prepared from a suitable iodide such as (**3**) (Scheme 2). This iodide contains the exact carbon skeleton of farnesol, and hence, in principle, the synthesis of the oxepane (**2**) could be achieved using only a single carbon–carbon bond-forming reaction. Alternatively, the geraniol derived iodide (**4**) could also be a possible precursor to the oxepane (**2**), with the remaining 5 carbons being added after formation of the cyclic ether. In either case, the required stereochemistry of the 1,2-diol could be obtained by *trans* ring opening of an epoxide.

In order to test the validity of such an oxepane synthesis, the model compound (**15**) was prepared as shown in Scheme 3. The starting material was the known epoxy tosylate (**5**), readily

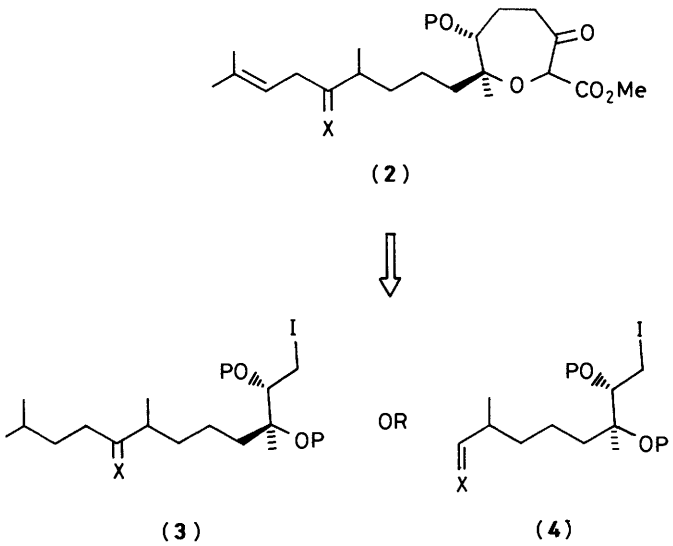


Scheme 1. *Reagents:* i, dianion of $MeCOCH_2CO_2Me$; ii, TsN_3, Et_3N, MeCN; iii, H_3O^+; iv, $Rh_2(OAc)_4$, benzene

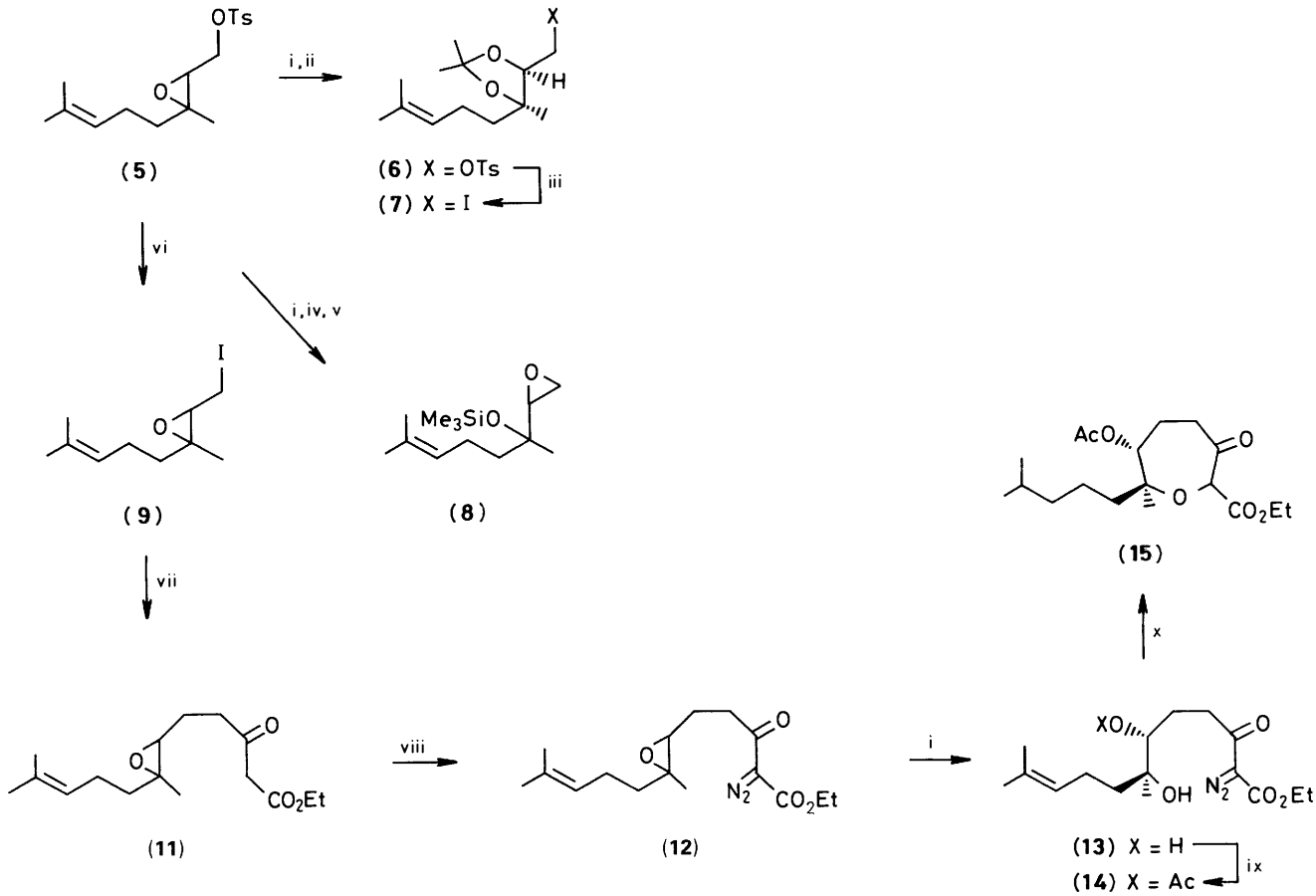
prepared from (*E*)-geraniol by epoxidation with t-butyl hydroperoxide and vanadyl acetylacetonate, followed by tosylation.[11] Initially, it was decided to establish the *trans*-diol unit before addition of the extra carbon atoms, so the epoxide (**5**) was opened in aqueous acidic tetrahydrofuran (THF), and the resulting diol converted into the acetonide (**6**). Displacement of the tosylate with iodide under forcing conditions in hot dimethylformamide (DMF) gave the iodoacetonide (**7**) in 61% yield. Although there is ample precedent for the *trans* opening of geraniol derived epoxides with inversion at C-3,[12] the stereochemistry of the acetonide (**7**) was confirmed by nuclear Overhauser effect (n.O.e.) difference spectroscopy. Pre-irradiation of the C-5 methine proton caused enhancements of two methyl signals, these due to the C-4 methyl and one of the C-2 methyls. However the iodide (**7**) proved extremely inert, and we were unable to displace it with a variety of carbanions. Therefore an alternative electrophile, the epoxide (**8**), was prepared by a Payne rearrangement. The epoxy tosylate (**5**) was ring opened as before, and the resulting diol treated with sodium carbonate to give the known rearranged epoxy alcohol,[11b] silylation of which gave the epoxide (**8**). Again, however, we

were unable to effect the alkylation of any useful carbanions with the epoxide (**8**).

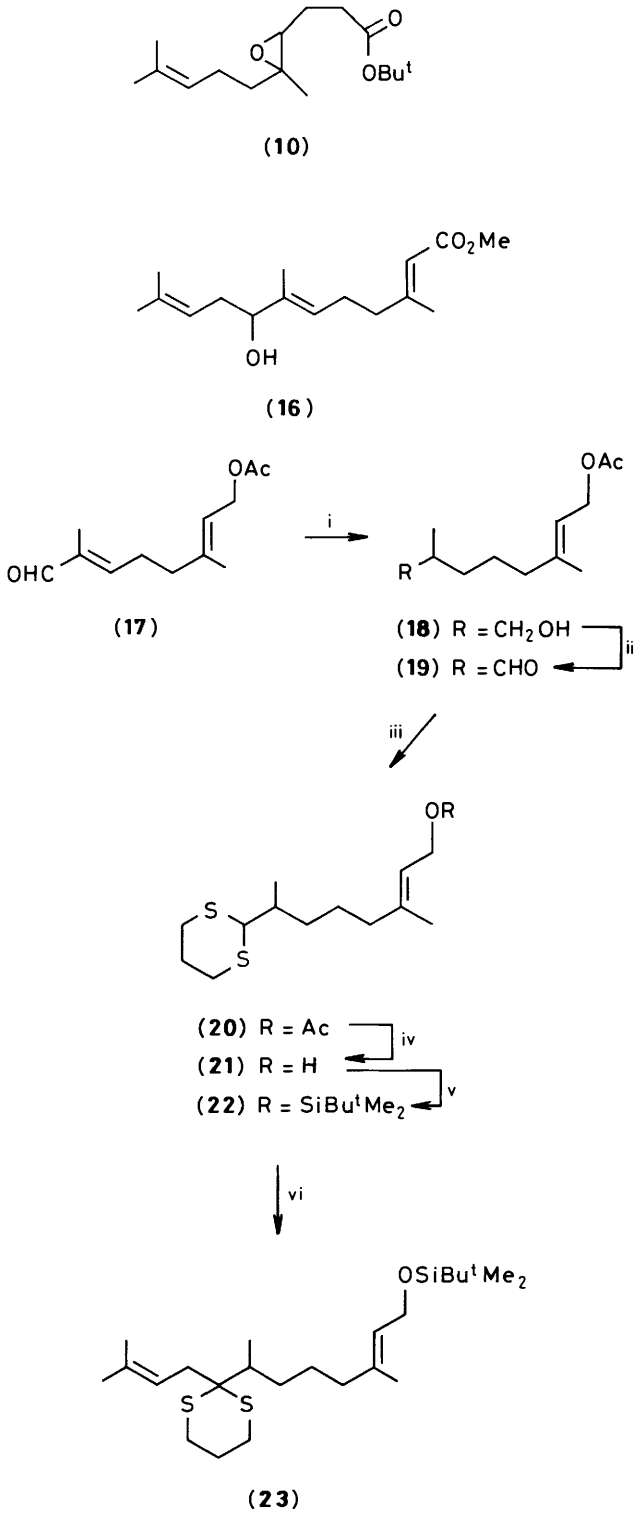
The alternative strategy involved carrying out an alkylation reaction before opening the epoxide, and therefore the epoxy iodide (**9**) was prepared in 81% yield by displacement of the corresponding tosylate. Although the iodide (**9**), a distillable oil, reacted with the dianion of methyl acetoacetate, the product was not the required β-keto ester. Instead, the carbanion attacked the iodine atom to give methyl 4-iodoacetoacetate and linalool. This was a little surprising since Yamada and co-workers have reported the reaction of a similar iodo epoxide with the anion of t-butyl acetate.[13] After correspondence with the Japanese workers, we carried out the reaction of our iodo epoxide (**9**) with the anion of t-butyl acetate, generating the anion in THF and hexamethylphosphoramide (HMPA) with lithium di-isopropylamide (LDA) as base, and adding it to the iodide, and obtained the alkylated product (**10**) in high yield, although we were unable to obtain the required β-keto ester (**11**) by addition of acetoacetate dianion under similar conditions. However, in the same personal communication, the reaction of the anion of ethyl acetate to give a β-keto ester was also described,[13b] and on carrying out the reaction of our iodo epoxide (**9**) with a 3-fold excess of the anion of ethyl acetate in THF and HMPA, we too obtained a β-keto ester, the required compound (**11**), albeit in poor yield (20—30%). Since the β-keto ester (**11**) could not be obtained completely pure, being contaminated with ethyl acetoacetate, it was used directly without complete characterisation. Diazo-transfer under the usual conditions proceeded smoothly to give the diazo epoxide (**12**) which was not isolated since it underwent facile ring opening, even on silica gel, to give the diazo diol (**13**). After purification the overall yield of diazo diol (**13**) from the iodo epoxide (**9**) was 9%, a figure which we were never able to improve because of the poor anion reaction. However, the diazo diol (**13**) appeared by t.l.c. and 250 MHz ^{1}H n.m.r. spectroscopy to be a single compound, and therefore it was carried through to



Scheme 2. P = suitable protecting group; X = O; H, OP; or protected carbonyl



Scheme 3. *Reagents:* i, H_3O^+; ii, $Me_2C(OMe)_2$, H^+; iii, NaI, DMF; iv, Na_2CO_3, MeOH; v, $Me_3SiOSO_2CF_3$, imidazole, DMF; vi, NaI, acetone; vii, $MeCO_2Et$, LDA, THF, HMPA, −78 °C; viii, TsN_3, Et_3N, MeCN; ix, Ac_2O, pyridine; x, $Rh_2(OAc)_4$, benzene



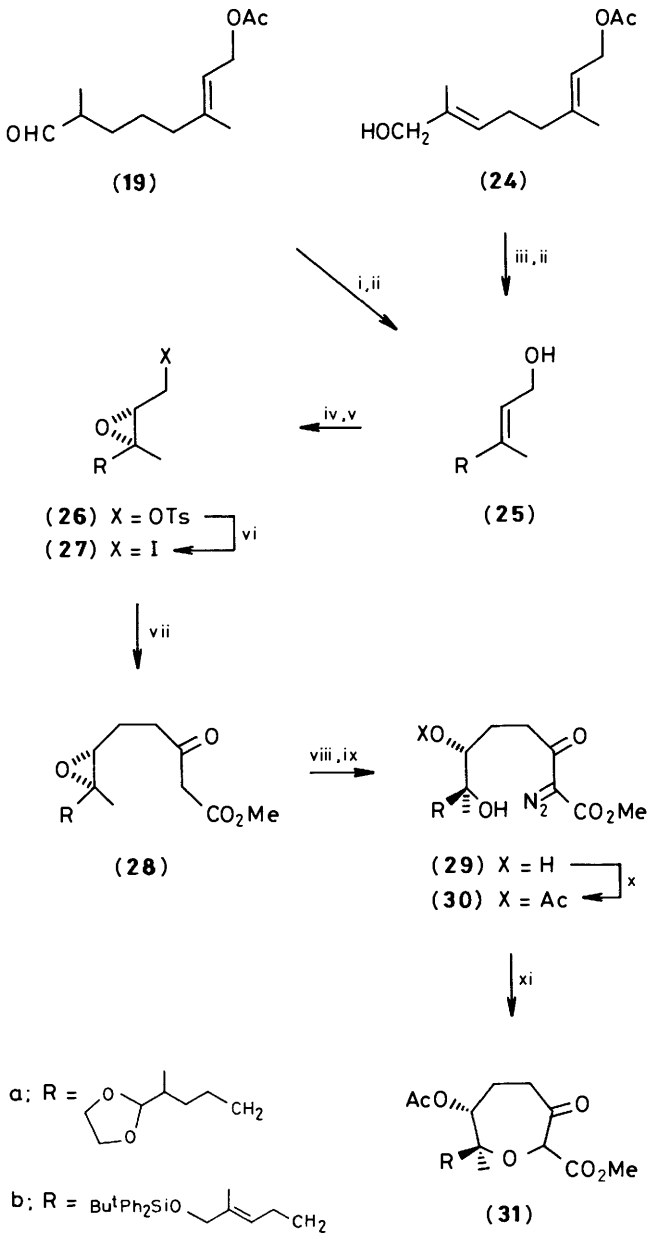
Scheme 4. *Reagents:* i, $Na_2S_2O_4$, $NaHCO_3$, Aliquat, benzene, water; ii, PCC, CH_2Cl_2; iii, $HS(CH_2)_3SH$, TsOH (cat.), CH_2Cl_2; iv, K_2CO_3, MeOH; v, Bu^tMe_2SiCl, imidazole, DMF; vi, BuLi, THF, 0 °C, then $Me_2C{=}CHCH_2Br$

the oxepane (**15**). Selective acetylation of the secondary alcohol gave the diazo alcohol (**14**) (74%), treatment of which with rhodium(II) acetate in boiling benzene resulted in cyclisation to give the oxepane (**15**), which in $CDCl_3$ solution seemed to be largely enolised, and was somewhat unstable, decomposing on attempted chromatography or with time in solution.

With the successful formation of the relatively complex oxepane (**15**) using the rhodium carbenoid mediated cyclisation reaction, we embarked on the preparation of a suitable precursor to the zoapatanol side chain, *cf.* (**3**) or (**4**). The use of farnesol as starting material was particularly attractive, but, although the allylic oxidation at the 8-position of a farnesol derivative has been reported to give (**16**) albeit in poor yield,[14] we were unable to obtain any useful products from the selenium dioxide oxidation of farnesyl acetate. Therefore the 15-carbon unit (**23**) was prepared from geraniol (Scheme 4).

Selenium dioxide oxidation of geranyl acetate gave the known aldehyde (**17**)[15,16] in about 30% yield on a multi-gram scale. We were unable to reduce the enal double bond using Raney nickel as previously reported,[15] and therefore used a phase-transfer sodium dithionite reduction.[17] This gave the aldehyde (**19**), together with the alcohol (**18**) which was reoxidised with pyridinium chlorochromate (PCC) in dichloromethane to give an overall yield of 68% of the aldehyde (**19**). The aldehyde (**19**) was converted into the dithiane (**20**), which was deacetylated, and reprotected as the silyl ether (**22**). Deprotonation of the dithiane with butyl-lithium followed by quenching with 3-methylbut-2-enyl (prenyl) bromide gave the 15-carbon unit (**23**) required for zoapatanol. Taking a lead from an earlier synthesis,[5] we planned to remove the thioketal at this stage and reprotect the ketone with the more easily removable ethylene ketal. However, all attempts to deprotect the dithiane (**23**) resulted in decomposition, and therefore this route was abandoned in favour of one involving the formation of oxepane ring before the addition of the terminal 5-carbon prenyl unit. Two terminally functionalised geraniol derived precursors were investigated; the aldehyde (**19**), protected as its ethylene acetal, and the known alcohol (**24**),[18] protected as its t-butyldiphenylsilyl ether. The alcohol (**24**), readily prepared by allylic oxidation of geranyl acetate according to the Sharpless modified selenium dioxide oxidation procedure,[18] had the advantage that in retaining the double bond, diastereoisomers due to the extra chiral centre were avoided. Both precursors were converted into the corresponding allylic alcohols (**25a,b**) (Scheme 5), the substrates for Sharpless asymmetric epoxidation, which was carried out using the catalytic version with t-butyl hydroperoxide, and (−)-diethyl tartrate (DET).[19] The resulting epoxy alcohols were tosylated *in situ* to give the epoxy tosylates (**26a**) (67%) and (**26b**) (57%). In the former case, some epoxy alcohol (11%) was also isolated, and this was acetylated, and the acetate analysed by 500 MHz ^1H n.m.r. spectroscopy in the presence of a chiral shift reagent, (−)-europium(III) tris[3-heptafluoropropylhydroxymethylene)-(+)-camphorate]. By observing the acetate methyl signal (two close singlets because of the 1:1 mixture of diastereoisomers due to the centre at C-7), we concluded that the enantiomeric excess of the Sharpless epoxidation of the alcohol (**25a**) was 93%, assuming that acetylation does not change the ratio.

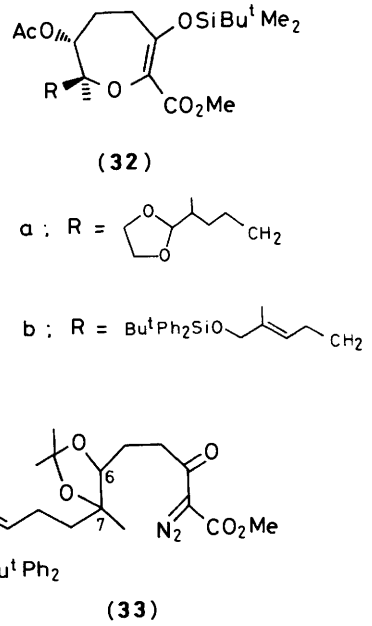
The epoxy tosylates (**26**) were converted into the corresponding iodides (**27**), which were treated with the dianion of methyl acetoacetate to give the β-keto esters (**28a**) (50%) and (**28b**) (61%), together with some of the 'linalool' type product derived by attack of the carbanion on iodine. In the case of the iodide (**27b**), the addition of 1,3-dimethyltetrahydropyrimid-2-one (DMPU) as co-solvent was necessary. The β-keto ester (**28**) underwent diazo transfer, followed by opening of the epoxide in aqueous acid, and selective acetylation of the resulting diazo diol (**29**) to give the diazo alcohol (**30**). The cyclisation of the diazo alcohols (**30**) in the presence of a catalytic amount of rhodium(II) acetate gave the optically active oxepanes (**31a**) (88%) and (**31b**) (88%). Like the simpler compound (**15**), the oxepanes (**31**) were very unstable, and could not be purified by chromatography, although the oxepane (**31a**) could be distilled. Unfortunately, this instability precluded rigorous structure



Scheme 5. *Reagents:* i, $HOCH_2CH_2OH$, camphorsulphonic acid, CH_2Cl_2; ii, K_2CO_3, EtOH; iii, Bu^tPh_2SiCl, imidazole, DMF; iv, Bu^tOOH, (−)-DET, $Ti(OPr^i)_4$, CH_2Cl_2; v, TsCl, Et_3N; vi, NaI, acetone; vii, $MeCOCH_2CO_2Me$, NaH, BuLi, THF (or THF–DMPU); viii, TsN_3, Et_3N, MeCN; ix, H_3O^+; x, Ac_2O, py, DMAP; xi, $Rh_2(OAc)_4$, benzene

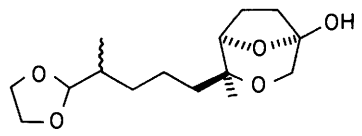
proof, particularly with regard to the stereochemistry, although the available evidence is consistent with the proposed structures.

In order to obtain some confirmatory evidence, the oxepane (**31a**), the ^1H n.m.r. of which was complicated due to presence of both keto and enol forms (although largely enolised), and of a 1:1 mixture of diastereoisomers due to the side-chain chiral centre, was converted into the silyl enol ether (**32a**) by treatment with t-butyldimethylsilyl trifluoromethanesulphonate. Although still a mixture of diastereoisomers, the cyclic ether (**32a**) exhibited a greatly simplifed n.m.r. spectrum which supported the structure. Likewise the oxepane (**31b**) was converted into the enol ether derivative (**32b**). As additional proof for the stereochemistry generated by opening of the epoxide, the diazo diol (**29b**), which is not complicated by the



presence of diastereoisomers, was converted into the acetonide (**33**), the stereochemistry of which was confirmed by n.O.e. difference spectroscopy. Pre-irradiation of the singlet at δ 1.25 due to the C-7 methyl group caused enhancement of the signal due to the C-6 methine, as did pre-irradiation of the singlet at δ 1.35 due to one of the methyl groups of the acetonide.

Finally, the unwanted ester substituent in the oxepane (**31a**) was removed by hydrolysis and decarboxylation. The product, formed in about 40% yield, is assigned the lactol structure (**34**). This is supported by the ^{13}C n.m.r. spectrum which shows no carbonyl, but a quaternary carbon at δ 102, which is presumably attached to two oxygens. However, the i.r. spectrum which shows carbonyl stretches, supports the alternative open hydroxy ketone structure.



(**34**)

In conclusion, we have shown that the rhodium carbenoid mediated cyclisation route to medium ring ethers can be used to prepare relatively complex oxepanes in optically active form, which although unstable, are possible advanced intermediates for the synthesis of the diterpene zoapatanol.

Experimental

For general points, see refs. 1 and 10.

(±)-2,3-*Epoxy*-3,7-*dimethyl*-1-(4-*tolylsulphonyloxy*)*oct*-6-*ene* (**5**) [2,3-*Epoxy*-(E)-*geraniol tosylate*].[11]—A solution of geraniol (11.25 ml, 10.00 g, 64.83 mmol) and vanadyl acetylacetonate (240 mg, 0.090 mmol) in dry benzene (70 ml) was treated with t-butyl hydroperoxide (2.40M in toluene; 27.00 ml, 5.84 g, 64.83 mmol) dropwise at room temperature under nitrogen. After 5 h, the orange solution was treated with pyridine (26 ml) and

concentrated cautiously on a rotary evaporator. The reaction vessel was purged with nitrogen and then the solution was treated with toluene-4-sulphonyl chloride (12.60 g, 66.13 mmol) and stirred for *ca.* 48 h at 4 °C. The resulting suspension was extracted with ether (600 ml), and the extract washed with water (2 × 200 ml), saturated aqueous copper sulphate (3 × 200 ml), water (200 ml), and brine (200 ml), dried ($MgSO_4$), and evaporated to give to the crude product as a yellow oil (20.96 g). Chromatography of this on silica (ethyl acetate–light petroleum, 1:6) gave the title compound (**5**) (20.01 g, 95%) as a clear colourless oil; $\nu_{max.}$(film) 3 500, 2 960, 2 910, 1 600, 1 440, 1 360, 1 180, 970, and 665 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.20 (3 H, s, 3-Me), 1.35—1.45 (1 H, m, 4-C*H*H), 1.52—1.68 (1 H, m, 4-C*H*H), 1.55 and 1.65 (6 H, s, 2 s, Me_2C=CH), 2.04 (2 H, m, 5-CH_2), 2.45 (3 H, s, ArMe), 2.95 (1 H, t, *J* 6.5 Hz, 2-CH), 4.10 (2 H, m, 1-CH_2), 4.50 (1 H, m, 6-CH), 7.35 (2 H, d, *J* 10.0 Hz, ArH), and 7.80 (2 H, d, *J* 10.0 Hz, ArH); *m/z* 324 (M^+), 255, 215, and 155.

4-(4-*Methylpent*-3-*enyl*)-2,2,4-*trimethyl*-5-(4-*tolylsulphonyloxy*)*methyl*-1,3-*dioxolane* (**6**).—A solution of racemic epoxy tosylate (**5**) (11.28 g, 34.81 mmol) in tetrahydrofuran (30 ml) and water (10 ml) was treated with perchloric acid (12 drops). The reaction mixture was heated to reflux for 4 h and then concentrated, diluted with ether (300 ml), washed with water (200 ml), and then with brine (2 × 100 ml) to neutrality. The aqueous phase was back extracted with ether (2 × 100 ml), and the combined organic extracts were evaporated to afford the crude diol as a yellow oil (10.18 g, 85%); $\nu_{max.}$(film) 3 500, 2 970, 2 920, 1 600, 1 450, 1 350, 1 190, 1 170, 965, 810, and 665 cm^{-1}.

A solution of the crude diol (10.18 g, 29.76 mmol) in 2,2-dimethoxypropane (18.30 ml, 15.50 g, 149.0 mmol) was treated with toluene-4-sulphonic acid (15 mg). The reaction mixture was stirred for 2 h at room temperature and then poured into dichloromethane (300 ml), washed with water (2 × 150 ml), dried ($MgSO_4$), and evaporated to afford the crude product (8.88 g, 79%). Chromatography of the latter on neutral alumina (light petroleum–ether–dichloromethane) gave the *acetonide* (**6**) (4.11 g, 36%) as a nearly colourless oil (Found: C, 62.6; H, 8.0. $C_{20}H_{30}O_5S$ requires C, 62.8; H, 7.9%), $\nu_{max.}$(film) 2 980, 2 930, 2 870, 1 600, 1 450, 1 370, 1 090, 1 060, 1 020, 980, and 810 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.00—1.50 (2 H, m, CH_2CMe), 1.26 and 1.32 (6 H, 2 s, 2-Me_2), 1.36 (3 H, s, 4-Me), 1.58 and 1.68 (6 H, 2 s, Me_2C=CH), 1.84—2.23 (2 H, m, =CHCH_2), 2.46 (3 H, s, ArMe), 3.90—4.02 (1 H, dd, *J* 7.0 Hz, *J* 5.5 Hz, 5-CH), 4.06—4.16 (2 H, m, CH_2OTs), 4.98—5.08 (1 H, m, Me_2C=C*H*), 7.36 (2 H, d, *J* 10.0 Hz, ArH), and 7.81 (2 H, d, *J* 10.0 Hz, ArH); *m/z* 382 (M^+), 367, 267, 155, 109, and 82.

5-*Iodomethyl*-4-(4-*methylpent*-3-*enyl*)-2,2,4-*trimethyl*-1,3-*dioxolane* (**7**).—A solution of the acetonide tosylate (**6**) (300 mg, 0.785 mmol) in dimethylformamide (2 ml) was treated with sodium iodide (259 mg, 1.73 mmol) and heated (100—120 °C) for 3 h. The reaction mixture was poured into water (50 ml), extracted with dichloromethane (50 ml), and the extract washed with aqueous sodium sulphite (10%; 2 × 50 ml) and water (2 × 50 ml), dried ($MgSO_4$), and evaporated to give a pale brown oil (202 mg, 76%). Chromatography of this on neutral alumina (light petroleum–dichloromethane) gave the *title compound* (**7**) (162 mg, 61%) as a pale yellow oil; b.p. 100—110 °C at 0.03 mmHg (Found: M^+, 323.0497. $C_{13}H_{23}IO_2 - CH_3$ requires *M*, 323.0508); $\nu_{max.}$(film) 2 980, 2 930, 2 870, 1 450, 1 380, 1 220, 1 110, 1 040, 1 015, and 820 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.19—1.60 (2 H, m, CH_2CMe), 1.30 and 1.37 (6 H, 2 s, 2-Me_2), 1.43 (3 H, s, 4-Me), 1.61 and 1.68 (6 H, 2 s, Me_2C=CH), 1.92—2.29 (2 H, m, =CHCH_2), 3.09—3.28 (2 H, m, CH_2I), 4.05 (1 H, dd, *J* 8.0 Hz, *J* 5.0 Hz, 5-CH), and 5.04—5.16 (1 H, m, Me_2C=C*H*); *m/z* 338 (M^+), 323, 263, 255, 129, 85, and 43.

2-(6-*Methyl*-2-*trimethylsiloxyhept*-5-*en*-2-*yl*)*oxirane* (**8**).—A solution of racemic epoxy-tosylate (**5**) (2.62 g, 8.09 mmol) in tetrahydrofuran (56 ml) and water (19 ml) was treated with perchloric acid (7 drops) and refluxed for 7 h as described above. Similar work-up gave crude diol. This crude diol (2.35 g, 6.87 mmol) was dissolved in dry methanol (52 ml) and the stirred mixture treated with anhydrous sodium carbonate (1.092 g, 10.31 mmol) at room temperature under nitrogen overnight. The reaction mixture was diluted with ether (250 ml), washed with water (2 × 200 ml) and brine (2 × 100 ml), dried ($MgSO_4$), and evaporated to give the crude product. Chromatography (light petroleum–ether, 12:1) gave the known tertiary alcohol,[11b] 2-(2-hydroxy-6-methylhept-5-en-2-yl)oxirane, as a colourless oil (992 mg, 72% over 2 steps); $\nu_{max.}$(film) 3 460, 2 960, 2 920, 1 665, 1 450, and 1 270 cm^{-1}.

A solution of the above alcohol (970 mg, 5.71 mmol) in dimethylformamide (3.80 ml) was treated with trimethylsilyl trifluoromethanesulphonate (1.32 ml, 1.52 g, 6.85 mmol) at 0 °C under nitrogen. The solution was stirred for 5 min before addition of imidazole (970 mg, 14.26 mmol). After a further 1 h at 0 °C, the reaction mixture was diluted with ether (150 ml), washed with water (3 × 50 ml) and brine (2 × 50 ml), dried ($MgSO_4$), and evaporated to give the crude product (1.20 g, 87%). Chromatography on silica (light petroleum–ethyl acetate, 20:1) gave the *title compound* (**8**) (714 mg, 52%) as a colourless oil; b.p. 85 °C at 0.25 mmHg (Found: C, 64.2; H, 10.9. $C_{13}H_{26}O_2Si$ requires C, 64.4; H, 10.8%); $\nu_{max.}$(film) 2 960, 2 930, 1 450, 1 370, 1 250, 1 045, and 835 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.11 (9 H, s, Me_3Si), 1.43—1.57 (2 H, m, CH_2CMe), 1.44 (3 H, s, CMe), 1.62 and 1.68 (6 H, 2 s, Me_2C=CH), 1.97—2.15 (2 H, m, Me_2C=CHCH_2), 2.66 (1 H, dd, J_{gem} 5.5 Hz, J_{trans} *ca.* 3.75 Hz, 3-C*H*H), 2.74 (1 H, dd, J_{gem} 5.5 Hz, J_{cis} 2.5 Hz, 3-C*H*H), 2.84 (1 H, dd, J_{trans} 3.75 Hz, J_{cis} 2.5 Hz, 2-CH), and 5.11 (1 H, m, Me_2C=C*H*); *m/z* 242 (M^+), 199, 143, 109, 73, 69, and 43.

2,3-*Epoxy*-1-*iodo*-3,7-*dimethyloct*-6-*ene* (**9**) [2,3-*Epoxy*-(E)-*geranyl Iodide*].—A solution of the racemic epoxy tosylate (**5**) (3.00 g, 9.26 mmol) in acetone (30 ml) was treated with sodium iodide (2.08 g, 3.9 mmol) at room temperature under nitrogen with the exclusion of light. After ~24 h, the reaction mixture was diluted with dichloromethane (200 ml), washed with aqueous sodium bisulphite (10%; 100 ml) and brine (2 × 100 ml), dried ($MgSO_4$), and evaporated to give the crude product as a pale yellow oil (2.134 g, 82%). Chromatography on silica (light petroleum–ethyl acetate, 20:1) gave the *title compound* (**9**) (2.11 g, 81%) as a colourless oil; b.p. 95—105 °C at 0.20 mmHg (Found: C, 43.1; H, 6.25; I, 45.3. $C_{10}H_{17}IO$ requires C, 42.9; H, 6.1; I, 45.3%); $\nu_{max.}$(film) 2 970, 2 915, 2 860, 1 450, 1 380, 1 175, 1 110, 1 070, 900, and 850 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.27 (3 H, s, 3-Me), 1.30—1.48 (1 H, m, 4-C*H*H), 1.61 and 1.68 (6 H, 2 s, Me_2C=CH), 1.64—1.80 (1 H, m, 4-C*H*H), 2.02—2.16 (2 H, m, 5-CH_2), 2.94—3.13 (2 H, m, 1-CH_2), 3.35 (1 H, dd, *J* 9.5 Hz, *J* 5.0 Hz, 2-CH), and 5.04—5.14 (1 H, m, 6-CH); *m/z* 281 (MH^+), 263, 153, 135, 109, 83, 71, and 43.

t-*Butyl*-4,5-*epoxy*-5,9-*dimethyldec*-8-*enoate* (**10**).—A standard solution of t-butyl lithioacetate was prepared as follows: diisopropylamine (1.97 ml, 1.42 g, 14.1 mmol) in tetrahydrofuran (42 ml) was cooled to −78 °C under nitrogen and then treated with butyl-lithium (1.6M; 8.00 ml, 820 mg, 12.81 mmol). The reaction mixture was stirred at −78 °C for 50 min before dropwise addition of t-butyl acetate (1.79 ml, 1.543 g, 13.28 mmol) in tetrahydrofuran (12 ml) over 5 min. The reaction mixture was maintained at −78 °C for a further 40 min before transfer by syringe of an aliquot of t-butyl lithioacetate (0.2M; 21.85 ml, 4.367 mmol) to a pre-cooled, nitrogen purged flask at −78 °C. A solution of the iodo epoxide (**9**) (673 mg, 2.40 mmol) in tetrahydrofuran (11 ml) and hexamethylphosphoramide (2

ml) cooled to −78 °C under nitrogen was treated with the preformed t-butyl lithioacetate (13.11 ml, 2.620 mmol) and the mixture stirred for 0.5 h; the remaining t-butyl lithioacetate (8.74 ml, 1.75 mmol) was then added to the reaction mixture. After a further 0.5 h at −78 °C, the reaction mixture was quenched with saturated aqueous ammonium chloride (~20 ml), and allowed to warm to room temperature. The mixture was extracted with ether (3 × 150 ml), and the ethereal extracts were washed with brine (100 ml), dried ($MgSO_4$), and evaporated to give the crude product (680 mg). Chromatography of this on silica (light petroleum–ethyl acetate, 40:1) gave the *title compound* (**10**) (539 mg, 84%) as a colourless oil; b.p. ~80 °C at 0.20 mmHg (Found: M^+, 212.1407. $C_{16}H_{28}O_3 - C_4H_8$ requires M, 212.1412); $\nu_{max.}$(film) 2 990, 2 920, 1 730, 1 450, 1 370, 1 155, 920, 850, and 735 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.25 (3 H, s, 5-Me), 1.25—1.48 (1 H, m, 6-C*H*H), 1.43 (9 H, s, Bu^t), 1.58 and 1.66 (6 H, 2 s, Me_2C=CH), 1.60—1.70 (1 H, m, 6-C*H*H), 1.70—1.85 (2 H, m, 3-CH_2), 1.98—2.10 (2 H, m, 7-CH_2), 2.30—2.38 (2 H, m, 2-CH_2), 2.69—2.76 (1 H, ~t, J ~6.5 Hz, 4-CH), and 4.98—5.11 (1 H, m, 8-CH); m/z 212 ($M^+ - C_4H_8$), 194, 153, 130, 110, 85, and 43.

(6R*,7S*)-*Ethyl* 2-*Diazo*-6,7-*dihydroxy*-7,11-*dimethyl*-3-*oxododec*-10-*enoate* (**13**).—A solution of di-isopropylamine (1.55 ml, 1.12 g, 11.07 mmol) in tetrahydrofuran (33 ml) was treated with butyl-lithium (1.6M; 6.30 ml, 64.5 mg, 10.07 mmol) at −78 °C under nitrogen. The reaction mixture was stirred for 50 min at −78 °C before addition of ethyl acetate (1.02 ml, 919 mg, 10.43 mmol) in tetrahydrofuran (10 ml). After a further 40 min, a solution of the iodo epoxide (**9**) (1.00 g, 3.57 mmol) in tetrahydrofuran (16 ml) and hexamethylphosphoramide (3 ml) was treated with the pre-formed ethyl lithioacetate solution dropwise *via* a catheter at −78 °C under nitrogen. After the addition of all the ethyl lithioacetate, the reaction mixture was stirred for a further 2 h, and then quenched with saturated aqueous ammonium chloride (10 ml) and extracted with ether (300 ml). The extract was then washed with water (3 × 150 ml) and brine (100 ml), dried ($MgSO_4$), and evaporated to give a yellow oil (1.30 g, >100%). Chromatography of this on silica (light petroleum–ether) gave (i) recovered iodide (**9**) (478 mg, 48%) and (ii) the epoxy β-keto ester (**11**) contaminated with ethyl acetoacetate (combined 303 mg); data for compound (**11**); $\nu_{max.}$(film) 2 960, 2 920, 1 735, 1 720, 1 630, 1 360, and 1 030 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.24 (3 H, s, 7-Me), 1.26 (3 H, t, J 7.0 Hz, OCH_2Me), 1.30—1.45 and 1.54—1.72 (2 H, 2 m, 8-CH_2), 1.58 and 1.67 (6 H, 2 s, Me_2C=CH), 1.82—1.97 (2 H, m, 5-CH_2), 1.98—2.10 (2 H, m, 9-CH_2), 2.65—2.75 (3 H, m, 4-CH_2 and 6-CH), 3.45 (2 H, s, 2-CH_2), 4.18 (2 H, q, J 7.0 Hz, OCH_2Me), and 5.99—6.08 (1 H, m, 10-CH); m/z 282 (M^+), 199, 194, 182, 157, 131, 85, and 69.

A solution of the impure epoxy β-keto ester (**11**) (303 mg) in dry acetonitrile (7.5 ml) was treated with tosyl azide (552 mg, 2.80 mmol) at 0 °C under nitrogen, followed by triethylamine (0.25 ml, 1.82 mg, 1.80 mmol). The reaction mixture was stirred at 4 °C for 18 h, and evaporated cautiously to give a waxy yellow residue, which was dissolved in ether (300 ml), and the solution washed with aqueous sodium hydroxide (5%; 100 ml), water (3 × 100 ml), and brine (100 ml), dried ($MgSO_4$), and evaporated to give the crude mixture. Chromatography of this on silica (light petroleum–ethyl acetate) gave the *diazo diol* (**13**) (105 mg, 9%) as a pale yellow oil, which solidified on refrigeration, m.p. 44—46 °C (Found: M^+, 282.1839. $C_{16}H_{26}N_2O_5 - N_2 - H_2O + 2H$ requires M, 282.1831); $\nu_{max.}$(film) 3 480, 2 970, 2 930, 2 140, 1 720, 1 660, 1 450, 1 375, and 735 cm^{-1}; δ_H(250 MHz; $CDCl_3$), 1.19 (3 H, s, 7-Me), 1.23—1.47 (1 H, m, 8-C*H*H), 1.33 (3 H, t, J 7.0 Hz, OCH_2Me), 1.50—1.80 (1 H, m, 8-C*H*H), 1.63 and 1.69 (6 H, 2 s, Me_2C=CH), 1.82—1.97 (1 H, m, 5-C*H*H), 1.97—2.23 (3 H, m, 9-CH_2 and 5-C*H*H), 2.83 (1 H, br d, 6-OH), 3.06 (2 H, ~t, J 7.0 Hz, 4-CH_2), 3.34—3.44 (1 H, m, 6-CH), 4.30 (2 H, q, J 7.0 Hz, OCH_2Me), and 5.07—5.18 (1 H, m, 10-CH); 7-OH not observed; m/z 282 ($M^+ - N_2 - H_2O + 2$ H), 216, 182, 156, 109, and 69.

(6R*,7S*)-*Ethyl* 6-*Acetoxy*-2-*diazo*-7-*hydroxy*-7,11-*dimethyl*-3-*oxododec*-10-*enoate* (**14**).—A solution of the diazo diol (**13**) (151 mg, 0.463 mmol) in pyridine (0.20 ml) was treated with acetic anhydride (0.13 ml, 142 mg, 1.39 mmol) at room temperature and the mixture stirred for 19 h. The reaction mixture was diluted with ether (100 ml), washed with water (3 × 50 ml), saturated aqueous copper sulphate (2 × 50 ml), water (50 ml), and brine (50 ml), dried ($MgSO_4$), and evaporated to give the crude product as a yellow oil (163 mg, 96%). Chromatography of this on silica (light petroleum–ethyl acetate, 4:1) gave the *diazo alcohol* (**14**) (126 mg, 74%) as a yellow oil (Found: M^+, 368.1932. $C_{18}H_{28}N_2O_6$ requires M, 368.1947); $\nu_{max.}$(film) 3 500, 2 980, 2 920, 2 140, 1 725, 1 660, 1 370, 1 310, 1 240, 1 030, and 740 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.20 (3 H, s, 7-Me), 1.33 (3 H, t, J 7.0 Hz, OCH_2Me), 1.46—2.21 (6 H, m, 5-CH_2, 8-CH_2, and 9-CH_2), 1.63 and 1.70 (6 H, 2 s, Me_2C=CH), 2.13 (3 H, s, OCOMe), 2.72—3.40 (2 H, m, 4-CH_2), 4.30 (2 H, q, J 7.0 Hz, OCH_2Me), 4.88 (1 H, dd, J 12.0 Hz, J 2.5 Hz, 6-CH), and 5.05—5.15 (1 H, m, 10-CH); 7-OH not observed; m/z 368 (M^+), 322, 285, 242, 206, 109, and 43.

(6R*,7S*)-*Ethyl* 6-*Acetoxy*-7-*methyl*-7-(4-*methylpent*-3-*enyl*)-3-*oxo*-*oxepane*-2-*carboxylate* (**15**).—A suspension of rhodium acetate (5 mg, 0.013 mmol) in dry benzene (21 ml) was treated at reflux with the diazo compound (**14**) (115 mg, 0.314 mmol) in dry benzene (20 ml) under nitrogen. After addition of all the diazo compound, the reaction mixture was refluxed for a further 1 h, cooled, and then filtered through a short pad of Celite before evaporation to give a clear viscous yellow oil (105 mg, 99%). The crude product was distilled (Kugelrohr) to give the *oxepane* (**15**) (92.5 mg, 87%) as an extremely viscous colourless oil; b.p. 145—155 °C at 0.125 mmHg (Found: M^+, 340.1893. $C_{18}H_{28}O_6$ requires M, 340.1886); $\nu_{max.}$(film) 3 460, 3 000, 2 940, 2 880, 1 740, 1 660, 1 630, 1 620, 1 380, 1 320, and 1 030 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.14 (3 H, s, 7-Me), 1.24 (3 H, t, J 7.5 Hz, OCH_2Me), 1.44—1.60 (2 H, m, CH_2CMe), 1.62 and 1.69 (6 H, 2 s, Me_2C=CH), 1.70—1.98 (3 H, m, 5-CH_2 and Me_2C=CHC*H*H), 2.06 (3 H, s, OCOMe), 2.26—2.42 (2 H, m, 4-C*H*H and Me_2C=CHC*H*H), 2.57—2.72 (1 H, m, 4-C*H*H), 4.16—4.33 (2 H, m, OCH_2Me), 4.62 (1 H, 2-CH, keto), 4.77 (1 H, dd, J ~2.5 Hz, 6-CH), 5.05—5.14 (1 H, m, Me_2C=C*H*), and 11.40 (1 H, s, OH, enol); m/z 340 (M^+), 298, 280, 262, 216, 135, and 69.

8-*Acetoxy*-2,6-*dimethyloct*-6-*ene*-1-*carbaldehyde* (**19**).—A solution of geraniol (56.24 ml, 50.00 g, 324 mmol) in pyridine (180 ml) was acetylated according to standard conditions with acetic anhydride (39.8 ml, 43.02 g, 421 mmol) to give crude geranyl acetate (62.90 g, 99%). Oxidation of this crude compound was carried out according to a literature procedure[15,16] with geranyl acetate (31.00 g, 201 mmol) and selenium dioxide (24.5 g, 211 mmol) in aqueous ethanol (95%; 250 ml) to give the crude product as a pale orange oil (37.92 g). Chromatography of this on silica (light petroleum–ether) gave the known aldehyde (**17**) as a yellow oil (9.91 g, 30%).

Reduction of the α,β-unsaturated aldehyde (**17**) to the saturated aldehyde (**19**) was carried out using a modified literature procedure for a related compound.[17] A suspension of the α,β-unsaturated aldehyde (**17**) (9.91 g, 47.19 mmol), sodium dithionite (88%; 25.70 g, 188 mmol), Aliquat (3.81 g, 9.50 mmol), and sodium hydrogen carbonate (19.82 g, 236 mmol) in a benzene (280 ml) and water (250 ml) mixture was heated to 80 °C for ~4 h. The reaction mixture was allowed to cool and the two phases were separated. The organic phase was

concentrated and then diluted with ether (300 ml), washed with brine (3 × 150 ml), dried ($MgSO_4$), and evaporated to give a pale yellow oil. Chromatography of this on silica (light petroleum–ether) gave the aldehyde (**19**) (5.01 g) as a colourless oil, along with the over-reduced product, 8-acetoxy-2,6-dimethyloct-6-en-1-ol (**18**) (1.86 g); $\nu_{max.}$(film) 3 400, 2 920, 1 735, 1 230, and 1 020 cm^{-1}; δ_H(90 MHz; $CDCl_3$) 0.95 (3 H, d, J ~7.0 Hz, 2-Me), 1.10—1.80 and 1.95—2.20 (7 H, m, 2-CH, 3-CH_2, 4-CH_2, and 5-CH_2), 1.70 (3 H, s, 6-Me), 2.05 (3 H, s, OCOMe), 3.50 (2 H, ~d, J 6.0 Hz, 1-CH_2), 4.65 (2 H, d, J 7.0 Hz, 8-CH_2), and 5.25—5.50 (1 H, m, 7-CH); m/z 154 (M^+ − HOAc).

The alcohol (**18**) (1.86 g, 8.69 mmol) in dichloromethane (6 ml) was oxidised back to the aldehyde (**19**) using pyridinium chlorochromate (2.93 g, 13.03 mmol) in dichloromethane (12 ml) with stirring at room temperature for ~2 h. The resulting black residue was filtered through silica, eluting with ether to give the *aldehyde* (**19**) (combined yield 6.83 g, 68%); b.p. 140 °C at 0.20 mmHg; $\nu_{max.}$(film) 2 930, 2 860, 1 735, 1 670, 1 460, 1 365, 1 235, and 1 020 cm^{-1}; δ_H(90 MHz; $CDCl_3$) 1.05 (3 H, d, J 7.0 Hz, 2-Me), 1.15—1.80 (4 H, m, 3-CH_2 and 4-CH_2), 1.70 (3 H, s, 6-Me), 1.90—2.15 (2 H, m, 5-CH_2), 1.90—2.50 (1 H, m, 2-CH), 2.00 (3 H, s, OCOMe), 4.55 (2 H, d, J 7.0 Hz, 8-CH_2), 5.30 (1 H, ~t, J ~7.0 Hz, 7-CH), and 9.50 (1 H, d, J ~2.0 Hz, CHO); m/z 212 (M^+ − COMe) and 152 (M^+ − HOAc).

1-*Acetoxy*-7-(1,3-*dithian*-2-*yl*)-3-*methyloct*-2-*ene* (**20**).—A solution of the aldehyde (**19**) (1.938 g, 9.14 mmol) in dichloromethane (90 ml) was treated with toluene-4-sulphonic acid (5 mol%; 87 mg, 0.46 mmol) followed by propane-1,3-dithiol (1.10 ml, 1.187 g, 10.97 mmol) at room temperature under nitrogen. The reaction mixture was stirred for ~3 h, diluted with dichloromethane (200 ml), washed with water (3 × 100 ml) and brine (100 ml), dried ($MgSO_4$), and evaporated to give the crude dithiane as a yellow oil (2.81 g, >100%). Chromatography of this on silica (light petroleum–ethyl acetate) gave the *dithiane* (**20**) (2.041 g, 74%) as a nearly colourless oil; b.p. ~255 °C at 0.45 mmHg (Found: C, 59.3; H, 8.9; S, 21.5. $C_{15}H_{26}O_2S_2$ requires C, 59.6; H, 8.7; S, 21.2%); $\nu_{max.}$(film) 2 930, 1 735, 1 420, 1 380, 1 360, 1 275, 1 230, and 1 020 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.07 (3 H, d, J 7.0 Hz, 7-Me), 1.22—1.61 (4 H, m, 5-CH_2 and 6-CH_2), 1.68 (3 H, s, 3-Me), 1.72—1.95 (1 H, m, 7-CH), 1.72—2.17 (4 H, m, $SCH_2CH_2CH_2S$ and 4-CH_2), 2.06 (3 H, s, OCOMe), 2.79—2.99 (4 H, m, $SCH_2CH_2CH_2S$), 4.12 (1 H, d, J ~4.0 Hz, SCHS), 4.63 (2 H, d, J 7.0 Hz, 1-CH_2), and 5.29—5.38 (1 H, m, 2-CH); m/z 302 (M^+), 242, 195, 119, and 106.

7-(1,3-*Dithian*-2-*yl*)-3-*methyloct*-2-*en*-1-*ol* (**21**).—A solution of the acetate (**20**) (1.014 g, 3.36 mmol) in methanol (10 ml) was treated with potassium carbonate (1.39 g, 10.07 mmol) at room temperature. After ~1 h, the reaction mixture was concentrated, diluted with ether (250 ml), washed with aqueous hydrochloric acid (10%; 60 ml), and then with water (4 × 100 ml) to neutrality, dried ($MgSO_4$), and evaporated to give the crude product as a yellow oil (743 mg, 85%). Chromatography on silica (light petroleum–ethyl acetate) gave the *title compound* (**21**) (573 mg, 66%) as a pale yellow oil (Found: M^+, 260.1261. $C_{13}H_{24}OS_2$ requires M, 260.1268); $\nu_{max.}$(film) 3 380, 2 930, 2 900, 1 665, 1 420, 1 380, 1 275, 1 000, and 910 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.08 (3 H, d, J 7.0 Hz, 7-Me), 1.21—1.63 (4 H, m, 5-CH_2, 6-CH_2), 1.65 (3 H, s, 3-Me), 1.71—1.91 (1 H, m, 7-CH), 1.71—2.15 (5 H, m, $SCH_2CH_2CH_2S$, 4-CH_2 and OH), 2.80—2.92 (4 H, m, $SCH_2CH_2CH_2S$), 4.10—4.18 (3 H, m, 1-CH_2 and SCHS), and 5.36—5.45 (1 H, m, 2-CH); m/z 260 (M^+), 242, 119, and 106.

1-*t-Butyldimethylsiloxy*-7-(1,3-*dithian*-2-*yl*)-2-*methyloct*-2-*ene* (**22**).—A solution of the alcohol (**21**) (413 mg, 1.58 mmol) in dimethylformamide (1.0 ml) was treated with t-butyldimethylsilyl chloride (251 mg, 1.66 mmol) followed by imidazole (269 mg, 3.96 mmol), and the mixture stirred at room temperature under nitrogen for 2 h. It was then extracted with ether (100 ml), washed with water (2 × 75 ml) and brine (50 ml), dried ($MgSO_4$), and evaporated to give a pale yellow oil (516 mg, 87%). Chromatography of this silica (light petroleum–ethyl acetate) gave the *title compound* (**22**) (447 mg, 75%) as a colourless oil; b.p. 215 °C at 1.0 mmHg (Found: C, 61.0; H, 10.35; S, 17.4. $C_{19}H_{38}OS_2Si$ requires C, 60.9; H, 10.2; S, 17.1%); $\nu_{max.}$(film) 2 940, 2 860, 1 670, 1 460, 1 380, 1 255, 840, and 775 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.04 (6 H, s, Me_2Si), 0.88 (9 H, s, Bu^{t}Si), 1.07 (3 H, d, J 7.0 Hz, 7-Me), 1.11—1.55 (4 H, m, 5-CH_2, 6-CH_2), 1.59 (3 H, s, 3-Me), 1.71—2.15 (5 H, m, SCH_2CH_2-CH_2S, 4-CH_2, and 7-CH), 2.78—2.96 (4 H, m, $SCH_2CH_2CH_2S$), 4.11 (1 H, d, J 4.5 Hz, SCHS), 4.17 (2 H, d, J 6.5 Hz, 1-CH_2), and 5.24—5.31 (1 H, m, 2-CH); m/z 374 (M^+), 317, 181, 119, and 75.

1-*t-Butyldimethylsiloxy*-3,7,11-*trimethyldodeca*-2,10-*dien*-8-*one Propylene Thioketal* (**23**).—A solution of the silyl ether (**22**) (155 mg, 0.414 mmol) in tetrahydrofuran (1 ml) was treated with butyl-lithium (1.6M; 0.340 ml, 0.538 mmol) at 0 °C under nitrogen. After being stirred for 2 h, the reaction mixture was treated with dimethylallyl bromide (123 mg, 0.827 mmol) and then stirred (0—5 °C) for a further 4 h. It was then extracted with ether (50 ml) and the extract washed with water (50 ml). The aqueous phase was extracted with ether (50 ml), and the combined organic extracts were washed with water (2 × 50 ml) and brine (50 ml), dried ($MgSO_4$), and evaporated to give a yellow oil containing some solid residue (64 mg). Chromatography of this on silica (light petroleum–ether, up to 20:1), gave the *thioketal* (**23**) (123 mg, 67%) as a nearly colourless oil; $\nu_{max.}$(film) 2 920, 2 860, 1 670, 1 520, 1 490, 1 380, 1 260, 1 060, 940, 910, 835, and 775 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.01 (6 H, s, Me_2Si), 0.84 (9 H, s, Bu^{t}Si), 1.01 (3 H, d, J 7.5 Hz, 7-Me), 1.05—1.32 (4 H, m, 5-CH_2 and 6-CH_2), 1.35—1.63 (1 H, m, 7-CH), 1.55 and 1.59 (6 H, 2 s, Me_2C=CH), 1.67 (3 H, s, 3-Me), 1.71—2.10 (6 H, m, $SCH_2CH_2CH_2S$, 9-CH_2 and 4-CH_2), 2.58—2.93 (4 H, m, $SCH_2CH_2CH_2S$), 4.20 (2 H, d, J 6.25 Hz, 1-CH_2), and 5.17—5.27 (2 H, m, 2-CH and 10-CH); m/z 442 (M^+), 373, 317, 299, 187, 119, and 75.

7-(1,3-*Dioxolan*-2-*yl*)-3-*methyloct*-2-*en*-1-*ol* (**25a**).—A solution of the saturated aldehyde (**19**) (1.64 g, 6.72 mmol), prepared as described earlier, in dry dichloromethane (8 ml) was treated with ethylene glycol (1.90 ml, 2.087 g, 33.63 mmol) followed by camphorsulphonic acid (7.8 mg, 0.34 mmol, 5 mol%). The reaction mixture was stirred for 3 h under nitrogen at room temperature, concentrated, diluted with ether (150 ml), and washed with brine (75 ml). The brine solution was re-extracted with ether (50 ml), and the combined organic extracts were dried ($MgSO_4$) and evaporated to give the *acetoxy dioxolane* (1.515 g, 88%) as a pale orange oil; b.p. ~100 °C at 0.30 mmHg (Found: C, 65.6; H, 9.7. $C_{14}H_{24}O_4$ requires C, 65.6; H, 9.4%); $\nu_{max.}$(film) 2 936, 2 860, 1 740, 1 671, 1 465, 1 367, 1 234, 1 152, 1 113, and 952 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.91 (3 H, d, J 7.0 Hz, 7-Me), 1.06—1.78 (5 H, m, 7-CH, 5-CH_2 and 6-CH_2), 1.68 (3 H, s, 3-Me), 1.93—2.09 (2 H, m, 4-CH_2), 2.03 (3 H, s, OCOMe), 3.78—3.96 (4 H, m, OCH_2CH_2O), 4.56 (2 H, d, J 7.0 Hz, 1-CH_2), 4.64 (1 H, d, J 4.0 Hz, OCHO), and 5.27—5.36 (1 H, m, 2-CH); m/z 256 (M^+), 225, 214, 197, 152, 126, and 73.

The crude product (1.515 g, 7.146 mmol) in absolute ethanol (10 ml) was treated with potassium carbonate (4.94 g, 35.0 mmol) at room temperature. After 1 h, the reaction mixture was diluted with ether (250 ml) and washed with brine (100 ml). The brine solution was washed with ether, and the combined organic extracts were washed with brine (100 ml), dried ($MgSO_4$), and evaporated to give a yellow oil. Chromatography of this on

silica (light petroleum–ether) gave the *dioxolane* (**25a**) (852 mg, 59% over 2 steps) as a colourless oil; b.p. ~133 °C at 0.25 mmHg (Found: C, 67.2; H, 10.5. $C_{12}H_{22}O_3$ requires C, 67.2; H, 10.35%); $\nu_{max.}$(film) 3 402, 2 936, 1 669, 1 465, 1 401, 1 230, 1 151, 1 094, 1 001, 950, and 651 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.92 (3 H, d, *J* 7.0 Hz, 7-Me), 1.07—1.78 (5 H, m, 7-CH, 5-CH_2, and 6-CH_2), 1.65 (3 H, s, 3-Me), 1.92—2.08 (2 H, m, 4-CH_2), 3.79—3.97 (4 H, m, OCH_2CH_2O), 4.12 (2 H, d, *J* 7.0 Hz, 1-CH_2), 4.49 (1 H, d, *J* 4.5 Hz, OC*H*O), and 5.34—5.44 (1 H, m, 2-CH); OH not observed; *m/z* 214 (M^+), 196, 152, 113, and 73.

(2R,3R)-7-(1,3-*Dioxolan*-2-*yl*)-2,3-*epoxy*-3-*methyl*-1-(4-*tolylsulphonyloxy*)*octane* (**26a**).—A suspension of activated powdered 4 Å molecular seives in dry dichloromethane (21 ml) maintained under nitrogen at −20 °C was treated sequentially with a solution of t-butyl hydroperoxide in dichloromethane (4.72M; 3.00 ml, 1.274 g, 14.16 mmol), (−)-diethyl tartrate (7.5 mol%; 173 μl, 208 mg, 1.01 mmol) and titanium tetraisopropoxide (5 mol%; 200 μl, 192 mg, 0.674 mmol). After the addition of the last component the reaction mixture was stirred at −20 °C for 0.25 h and then cooled to −40 °C before the dropwise addition of allylic alcohol (**25a**) (2.890 g, 13.48 mmol) in dry dichloromethane (3.6 ml) with continued stirring. The reaction mixture was then allowed to warm to −20 °C over 1 h after which it was stirred for a further 6 h at this temperature. The suspension was treated with triethylamine (2.25 ml, 1.64 g, 16.18 mmol) at −20 °C, followed by toluene-4-sulphonyl chloride (2.620 g, 13.76 mmol) in dichloromethane (2.5 ml); the mixture was then allowed to warm to 0 °C. After this it was stirred (0—5 °C) for 36 h, and the resulting yellow suspension concentrated and poured onto a silica column. Chromatography (light petroleum–ether) gave (i) the (2R,3R)-*epoxy tosylate* (**26a**) (3.464 g, 67%) as a colourless oil, $[\alpha]_D^{25}$ +17.1° (*c* 1.00, CH_2Cl_2); $\nu_{max.}$(film) 2 942, 2 880, 1 598, 1 465, 1 364, 1 177, 1 097, 964, and 666 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.91 (3 H, d, *J* 7.0 Hz, 7-Me), 1.05—1.73 (7 H, m, 7-CH, 6-CH_2, 5-CH_2, and 4-CH_2), 1.19 (3 H, s, 3-Me), 2.48 (3 H, s, ArMe), 2.91—2.98 (1 H, m, 2-CH), 3.81—3.96 (4 H, m, OCH_2CH_2O), 4.02—4.17 (2 H, m, **1**-CH_2), 4.63 (1 H, 2 d, *J* 4.5 Hz, OC*H*O), 7.36 (2 H, 2 d, *J* 7.5 Hz, ArH), and 7.80 (2 H, d, *J* 7.5 Hz, ArH); *m/z* 384 (M^+), 282, 236, 185, 155, 113, and 55; and (ii) (2R,3R)-7-(1,3-*dioxolan*-2-*yl*)-2,3-*epoxy*-3-*methyloctan*-1-*ol* (323 mg, 11%) as a colourless oil, $[\alpha]_D^{25}$ +5.00° (*c* 1.00, CH_2Cl_2) (Found: M^+, 229.1440. $C_{12}H_{22}O_4$ − H requires *M*, 229.1440); $\nu_{max.}$(film) 3 436, 2 941, 1 466, 1 386, 1 228, 1 099, 1 033, 949, 870, and 661 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.91 (3 H, d, *J* 7.0 Hz, 7-Me), 1.03—1.77 (7 H, m, 7-CH, 6-CH_2, 5-CH_2, and 4-CH_2), 1.27 (3 H, s, 3-MeC), 1.88 (1 H, br s, OH), 2.90—2.97 (1 H, m, 2-CH), 3.61—3.96 (6 H, m, 1-CH_2 and OCH_2CH_2O), and 4.64 (1 H, d, *J* 4.5 Hz, OC*H*O); *m/z* 229 (M^+ − H), 199, 185, 169, and 73.

(2R,3R)-1-*Acetoxy*-7-(1,3-*dioxolan*-2-*yl*)-2,3-*epoxy*-3-*methyloctane*.—A solution of the above epoxy alcohol (257 mg, 1.12 mmol) in pyridine (0.8 ml) was treated with acetic anhydride (0.53 ml, 570 mg, 5.59 mmol) and 4-dimethylaminopyridine (5 mg). The reaction mixture was stirred at room temperature for 3 h and then diluted with ether (200 ml), washed with water (2 × 100 ml) and saturated aqueous copper sulphate (2 × 50 ml), and brine (100 ml), dried ($MgSO_4$), and evaporated to give the crude product as a yellow oil (282 mg). Chromatography of this on silica (light petroleum–ether) gave the *title compound* (214 mg, 71%) as a colourless oil, $[\alpha]_D^{25}$ +19.2° (*c* 1.00, CH_2Cl_2) (Found: C, 61.7; H, 9.05. $C_{14}H_{24}O_5$ requires C, 61.7; H, 8.9%); $\nu_{max.}$(film) 2 942, 2 883, 1 746, 1 466, 1 377, 1 235, 1 156, 1 099, and 948 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.91 (3 H, d, *J* 7.0 Hz, 7-Me), 1.08—1.77 (7 H, m, 7-CH, 6-CH_2, 5-CH_2, 4-CH_2), 1.29 (3 H, s, 3-Me), 2.09 (3 H, s, OCOMe), 2.93—3.01 (1 H, m, 2-CH), 3.77—3.97 (4 H, m, OCH_2CH_2O), 4.02 (1 H, dd, J_{gem} 12.0 Hz, J_{AB} 7.0 Hz, 1-C*H*H), 4.30 (1 H, dd, J_{gem} 12.0 Hz, J_{AB} 4.0 Hz, 1-C*H*H), and 4.64 (1 H, d, *J* 4.5 Hz, OC*H*O); *m/z* 272 (M^+), 213, 199, 185, 169, and 73.

(2R,3R)-7-(1,3-*Dioxolan*-2-*yl*)-2,3-*epoxy*-1-*iodo*-3-*methyloctane* (**27a**).—A solution of the epoxy tosylate (**26a**) (3.437 g, 8.950 mmol) in acetone (32 ml) was treated with sodium iodide (2.68 g, 17.90 mmol), and the mixture refluxed under nitrogen for 2 h. The resulting suspension was diluted with ether (250 ml), washed with water (150 ml), aqueous sodium metabisulphite (80 ml), aqueous sodium hydrogen carbonate (50 ml), water (2 × 100 ml), and brine (100 ml), dried ($MgSO_4$), and evaporated to give the crude product as a pale yellow oil (2.844 g, 93%). Chromatography of this on silica (light petroleum–ether) gave the (2R,3R)-*epoxy iodide* (**27a**) (2.263 g, 74%) as a colourless oil, $[\alpha]_D^{25}$ −22.5° (*c* 1.00, CH_2Cl_2); b.p. ~100 °C at 0.15 mmHg (Found: C, 42.6; H, 6.3; I, 37.1 $C_{12}H_{21}IO_3$ requires C, 42.4; H, 6.2; I, 37.3%); $\nu_{max.}$(CCl_4) 2 927, 2 855, 1 467, 1 381, 1 355, and 1 120 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.93 (3 H, d, *J* 7.5 Hz, 7-Me), 1.05—1.78 (7 H, m, 7-CH, 6-CH_2, 5-CH_2, and 4-CH_2), 1.26 (3 H, s, 3-Me), 2.92—3.13 (2 H, m, 1-CH_2), 3.33 (1 H, dd, *J* 9.0 Hz, *J* 5.0 Hz, 2-CH), 3.77—3.98 (4 H, m, OCH_2CH_2O), and 4.65 (1 H, d, *J* 4.5 Hz, OC*H*O); *m/z* 339 (M^+ − H), 243, 213, 169, 151, 113, 73, and 55.

(6R,7S)-*Methyl* 11-(1,3-*Dioxolan*-2-*yl*)-6,7-*epoxy*-7-*methyl*-3-*oxododecanoate* (**28a**).—A suspension of sodium hydride (50% dispersion in oil; 188 mg, 3.93 mmol) in tetrahydrofuran (18 ml) was prepared under nitrogen at 0 °C. Methyl acetoacetate (0.44 ml, 478 mg, 4.12 mmol) was added, and the mixture stirred for 0.25 h, before the addition of butyl-lithium (1.6M; 2.40 ml, 3.83 mmol). The dianion solution was cooled to −10 °C and then transferred by catheter to a solution of the iodo epoxide (**27a**) (636 mg, 1.87 mmol) in tetrahydrofuran (18 ml), maintained at 0 °C under nitrogen. After a further 2.5 h, the reaction mixture was quenched with saturated aqueous ammonium chloride (100 ml), diluted with ether (250 ml), washed with water (2 × 150 ml) and brine (100 ml), dried ($MgSO_4$), and evaporated to give the crude mixture as a yellow oil (596 mg). Chromatography of this on silica (light petroleum–ether) gave (i) the *title compound* (**28a**) (308 mg, 50%) as a colourless oil, $[\alpha]_D^{25}$ +10.1° (*c* 1.00, CH_2Cl_2); b.p. 154 °C at 0.015 mmHg (Found: C, 62.4; H, 8.55. $C_{17}H_{28}O_6$ requires C, 62.2; H, 8.6%); $\nu_{max.}$(film) 3 510, 2 938, 2 880, 1 747, 1 719, 1 655, 1 631, 1 322, 1 250, and 947 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.92 (3 H, d, *J* 6.5 Hz, 11-Me), 1.06—2.01 (9 H, m, 11-CH, 10-CH_2, 9-CH_2, 8-CH_2, and 5-CH_2), 1.24 (3 H, s, 7-Me), 2.65—2.76 (3 H, m, 4-CH_2 and 6-CH), 3.47 (2 H, s, 2-CH_2), 3.72 (3 H, s, OMe), 3.78—3.96 (4 H, m, OCH_2CH_2O), and 4.62 (1 H, d, *J* 5.5 Hz, OC*H*O); *m/z* 328 (M^+), 296, 254, 159, and 73; and (ii) (3R)-7-(1,3-*dioxolanyl*)-3-*methyloct*-1-*en*-3-*ol* (106 mg, 26%) as a colourless oil, $[\alpha]_D^{25}$ −8.9° (*c* 1.00, CH_2Cl_2); b.p. 105—108 °C at 0.003 mmHg (Found: M^+, 214.1575. $C_{12}H_{22}O_3$ requires *M*, 214.1569); $\nu_{max.}$(film) 3 456, 2 965, 2 930, 2 880, 1 641, 1 466, 1 403, 1 369, and 1 110 cm^{-1}; δ_H (250 MHz, $CDCl_3$) 0.90 (3 H, d, *J* 7.0 Hz, 7-Me), 1.06—1.76 (7 H, m, 7-CH, 6-CH_2, 5-CH_2, and 4-CH_2), 1.24 (3 H, s, 3-Me), 3.77—3.95 (4 H, m, OCH_2CH_2O), 4.64 (1 H, d, *J* 4.5 Hz, OC*H*O), 5.01 (1 H, dd, J_{cis} 11.0 Hz, J_{gem} 1.25 Hz, 1-C*H*H), 5.16 (1 H, dd, J_{trans} 17.0 Hz, J_{gem} 1.25 Hz, 1-C*H*H), and 5.88 (1 H, dq, J_{trans} 17.0 Hz, J_{cis} 11.0 Hz, J_{OH} 1.25 Hz, 2-CH); OH not observed; *m/z* 214 (M^+), 199, 181, 159, 143, 113, and 73.

(6R,7S)-*Methyl* 2-*Diazo*-11-(1,3-*dioxolan*-2-*yl*)-6,7-*dihydroxy*-7-*methyl*-3-*oxododecanoate* (**29a**).—A solution of the β-keto ester (**28a**) (660 mg, 2.012 mmol) in dry acetonitrile (12 ml) was treated with toluene-4-sulphonyl azide (396 mg. 2.012 mmol) in acetonitrile (0.5 ml), followed by triethylamine (0.34

ml, 244 mg, 2.42 mmol), at 0 °C under nitrogen. After a further 13 h at ~4 °C, the reaction mixture was carefully evaporated, and the residue dissolved in ether (250 ml), washed with aqueous sodium hydroxide (5%; 150 ml), water (2 × 150 ml), and brine (200 ml), dried ($MgSO_4$), and evaporated to give the intermediate diazo epoxide (644 mg, 71%) as a yellow oil, $[\alpha]_D^{25}$ 11.5° (*c* 1.00, CH_2Cl_2); $\nu_{max.}$(film) 2 941, 2 880, 2 137, 1 724, 1 660, 1 438, 1 213, 1 137, and 746 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.90 (3 H, d, *J* 7.0 Hz, 11-Me), 1.06—1.99 (9 H, m, 11-CH, 10-CH_2, 9-CH_2, 8-CH_2, and 5-CH_2), 1.23 (3 H, s, 7-Me), 2.72—2.80 (1 H, m, 6-CH), 2.99 (2, H, t, *J* 7.5 Hz, 4-CH_2), 3.77—3.96 (4 H, m, OCH_2CH_2O), and 4.64 (1 H, d, *J* 4.5 Hz, OC*H*O).

The crude diazo epoxide was dissolved in a tetrahydrofuran and water mixture (3:1; 14 ml) and treated with perchloric acid (3 drops) at room temperature. After 1 h, the reaction mixture was diluted with ether (500 ml), washed with water (3 × 200 ml) and brine (100 ml), dried ($MgSO_4$), and evaporated to give a yellow oil (685 mg). Chromatography of this on silica (hexane–dichloromethane–5% methanol in dichloromethane) gave the *title compound* (**29a**) (542 mg, 72% over 2 steps) as a viscous yellow oil which solidified on refrigeration to give a waxy yellow solid, $[\alpha]_D^{25}$ −0.40° (*c* 1.00, CH_2Cl_2); m.p. 44—45 °C (Found: C, 54.6; H, 7.7; N, 7.7. $C_{17}H_{28}N_2O_7$ requires C, 54.8; H, 7.6; N, 7.5%); $\nu_{max.}$(film) 3 473, 2 953, 2 880, 2 139, 1 724, 1 654, 1 439, 1 314, 1 212, and 760 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.92 (3 H, d, *J* 7.0 Hz, 11-Me), 1.08—2.25 (11 H, m, 2-OH, 11-CH, 10-CH_2, 9-CH_2, 8-CH_2, and 5-CH_2), 1.14 (3 H, 2 s, 7-Me), 3.02 (2 H, 2 t, *J* 7.0 Hz, 4-CH_2), 3.36 (1 H, ~dd, *J* 11.0 Hz, *J* 2.0 Hz, 6-CH), 3.76—3.98 (4 H, m, OCH_2CH_2O), 3.82 (3 H, s, OMe), and 4.65 (1 H, 2 d, *J* 4.5 Hz, OC*H*O); *m/z* 372 (M^+), 344., 354, 326, 271, 201, 55, and 73.

(6R,7S)-*Methyl* 6-*Acetoxy*-2-*diazo*-11-(1,3-*dioxolan*-2-*yl*)-7-*hydroxy*-7-*methyl*-3-*oxododecanoate* (**30a**).—A solution of the diazo diol (**29a**) (495 mg, 1.33 mmol) in pyridine (3 ml) was treated with acetic anhydride (0.38 ml, 407 mg, 3.99 mmol) and 4-dimethylaminopyridine (10 mg) and the mixture stirred at room temperature under nitrogen. After 6 h, the reaction mixture was diluted with ether (300 ml), washed with water (2 × 150 ml), saturated aqueous copper sulphate (2 × 100 ml), saturated aqueous sodium hydrogen carbonate (20 ml), water (100 ml), and brine (100 ml), dried ($MgSO_4$), and evaporated to give a yellow oil (470 mg, 88%). Chromatography of this on silica (hexane–ether) gave the *title compound* (**30a**) (374 mg, 68%) as a viscous yellow oil, $[\alpha]_H^{25}$ −3.5° (*c* 1.00, CH_2Cl_2) (Found: C, 54.9; H, 7.5; N, 6.7. $C_{19}H_{30}N_2O_7$ requires C, 55.0; H, 7.3; N, 6.8%); $\nu_{max.}$(film) 3 500, 2 953, 2 880, 2 138, 1 729, 1 654, 1 438, 1 373, 1 313, 1 032, and 746 cm^{-1}; δ_H(25.0 MHz; $CDCl_3$) 0.93 (3 H, d, *J* 7.0 Hz, 11-Me), 1.30—1.54 (4 H, m, 9-CH_2 and 10-CH_2), 1.14 (3 H, s, 7-Me), 1.56—1.88 (5 H, m, 5-C*H*H, 8-CH_2, 11-CH, and OH), 2.00—2.18 (1 H, m, 5-C*H*H), 2.08 (3 H, s, OCOMe), 2.70—3.01 (2 H, m, 4-CH_2), 3.78—3.96 (4 H, m, OCH_2CH_2O), 3.79 (3 H, s, OMe), 4.65 (1 H, d, *J* 4.5 Hz, OC*H*O), and 4.80—4.88 (1 H, m, 6-CH); *m/z* 370 ($M^+ - N_2$), 328, 310, 228, 167, and 73.

(6R,7S)-*Methyl* 6-*Acetoxy*-7-[4-(1,3-*dioxolan*-2-*yl*)*pentyl*]-7-*methyl*-3-*oxo*-*oxepane*-2-*carboxylate* (**31a**).—A suspension of rhodium acetate (7 mg, 0.016 mmol) in refluxing dry benzene (24 ml) was treated with the diazo alcohol (**30a**) (328 mg, 0.575 mmol) in dry benzene (22 ml). After addition of all the diazo alcohol (**30a**), the reaction mixture was refluxed for a further 0.5 h under nitrogen, cooled and filtered through Celite. The Celite was washed with benzene (100 ml), and the combined benzene solutions were evaporated to give a pale yellow oil (231 mg, >100%). Distillation of the crude product gave the (6R,7S)-*oxepane* (**31a**) (195 mg, 88%) as an extremely viscous colourless oil, $[\alpha]_D^{25}$ −8.5° (*c* 1.00, CH_2Cl_2); b.p. 142—145 °C at 0.005 mmHg (Found: M^+, 386.1946. $C_{19}H_{30}O_8$ requires *M*, 386.1941); $\nu_{max.}$(CCl_4) 2 953, 2 880, 1 743, 1 662, 1 622, 1 448, 1 346, 1 322, 1 238, 1 162, and 935 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.92 and 0.94 (3 H, 2 d, *J* 7.0 Hz, *Me*CH,keto/enol*), 1.095 and 1.10 (3 H, 2 s, 7-Me), 1.13—1.81 [8 H, m, 5-C*H*H and MeC*H*(CH_2)$_3$], 1.82—1.95 (1 H, m, 5-C*H*H), 2.03 (3 H, 2 s, OCOMe*), 2.27—2.46 (1 H, m, 4-C*H*H, enol), 2.91—3.22 (2 H, m, 4-CH_2, keto), 3.75 and 3.78 (3 H, 2 s, OMe*), 3.79—3.98 (4 H, m, OCH_2CH_2O), 4.63—4.68 (2 H, m, OC*H*O and 2-CH, keto), 4.74—4.82 (1 H, m, 6-CH, enol), 4.87—4.96 (1 H, m, 6-CH, keto), and 10.94 (1 H, 2 s, OH, enol); *m/z* 386 (M^+), 344, 326, 210, 185, 113, and 73.

(6R,7S)-*Methyl* 6-*Acetoxy*-3-*t*-*butyldimethylsiloxy*-7-[4-(1,3-*dioxolan*-2-*yl*)*pentyl*]-7-*methyl*-4,5,6,7-*tetrahydro*-*oxepine*-2-*carboxylate* (**32a**).—A solution of the oxepane (**31a**) (36 mg, 0.093 mmol) in dry ether (0.65 ml) and dry dichloromethane (0.5 ml) was treated with triethylamine (14 μl, 10.4 mg, 0.103 mmol) followed by t-butyldimethylsilyl trifluoromethanesulphonate (36 μl, 41.4 mg, 0.157 mmol) with stirring at room temperature under nitrogen. After being stirred for 17 h, the reaction mixture was diluted with ether (25 ml), washed with water (2 × 20 ml), saturated aqueous sodium hydrogen carbonate (few drops) in water (10 ml), and brine (10 ml), dried ($MgSO_4$), and evaporated to give a colourless oil (41 mg, 81%). Chromatography (light petroleum–ether) of this gave the *title compound* (**32a**) (26 mg, 57%) as a clear colourless glass, $[\alpha]_D^{25}$ −2.96° (*c* 2.3, CH_2Cl_2) (Found: M^+, 500.2802. $C_{25}H_{44}O_8Si$ requires *M*, 500.2805); $\nu_{max.}$(CCl_4) 2 951, 2 930, 2 865, 2 882, 1 741, 1 718, 1 625, 1 437, 1 370, 1 243, 1 062, 1 031, and 840 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 0.16 (6 H, 2 s, Me_2Si), 0.90—0.99 (3 H, ~2 d, *J* 7.0 Hz, *Me*CH), 0.94 (9 H, bs, Bu^{t}Si), 1.09—1.84 [9 H, m, MeC*H*(CH_2)$_3$ and 5-CH_2], 1.14 and 1.15 (3 H, 2 s, 7-Me), 2.03 (3 H, s, OCOMe), 2.17—2.30 (1 H, m, 4-C*H*H), 2.58—2.74 (1 H, m, 4-C*H*H), 3.69 (3 H, s, OMe), 3.77—3.97 (4 H, m, OCH_2-CH_2O), 4.65 and 4.67 (1 H, 2 d, *J* 2.5 Hz, OC*H*O), and 4.72—4.81 (1 H, m, 6-CH); *m/z* 500 (M^+), 485, 443, 383, and 113.

(1R,4S,5R)-4-[4-(1,3-*Dioxolan*-2-*yl*)*pentyl*]-1-*hydroxy*-4-*methyl*-3,8-*dioxabicyclo*[3.2.1]*octane* (**34**).—A solution of the oxepane β-keto ester (**31a**) (38 mg, 0.098 mmol) in toluene (2 ml) was treated with aqueous sodium hydroxide (2M; 0.20 ml, 0.40 mmol) and refluxed for 2 h. The reaction mixture was acidified to pH 2 with aqueous hydrochloric acid (1.44M) and allowed to reflux for a further 5 min after which it was diluted with water (100 ml) and extracted with ether (2 × 100 ml). The combined ether extracts were washed with water (100 ml) and brine (100 ml), dried ($MgSO_4$), and evaporated to give a nearly colourless oil (39 mg, >100%). Chromatography of this on silica (hexane–ether) gave the *title compound* (**34**) (12 mg, 42%) as a colourless oil, $[\alpha]_D^{25}$ −0.026° (*c* 1.25, CH_2Cl_2) (Found: M^+, 286.1783. $C_{15}H_{26}O_5$ requires 286.1780); $\nu_{max.}$(CCl_4) 3 600, 2 952, 2 880, 1 788, 1 742, 1 648, 1 370, 1 238, 1 119, and 939 cm^{-1}; δ_H(500 MHz; $CDCl_3$), tentatively assigned as: 0.93 (3 H, 2 d, *J* 7.0 Hz, *Me*CH), 1.12—1.56 [6 H, m, MeCH(CH_2)$_3$], 1.33 (3 H, s, 4-Me), 1.61—1.75 (2 H, m, MeC*H* and 7-C*H*H), 1.93—2.08 (2 H, m, 6-CH_2), 2.15—2.23 (2 H, m, OH and 7-C*H*H), 3.45 (1 H, ~d, *J* ~11.0 Hz, 2-C*H*H), 3.68 (1 H, (1 H, ~d, *J* ~11.0 Hz, 2-C*H*H), 3.82—3.86 (2 H, m, OCH_2CH_2O), 3.90—3.96 (3 H, m, OCH_2CH_2O, and 5-CH), and 4.64 (1 H, 2 d, *J* 3.0 Hz, OC*H*O); δ_C(62.9 MHz; $CDCl_3$) C and CH_2, 21.0, 23.8, 32.3, 33.2, 38.4, 65.0, 69.31, 74.9, 102.3; CH and Me, 13.9, 18.4, 36.9, 81.3, 107.8; some peaks appear as pairs of very narrowly separated lines

* Pattern further complicated by the presence of keto and enol forms of both diastereoisomers.

because of the presence of 2 diastereoisomers; *m/z* 286 (M^+), 271, 256, 242, 201, 185, and 73.

8-(*t-Butyldiphenylsiloxy*)-3,7-*dimethylocta*-2,6-*dien*-1-*ol* (**25b**).—Oxidation of geranyl acetate (17.0 g, 0.087 mol) was carried out according to a modified literature procedure[18] using selenium dioxide (220 mg, 1.98 mmol), t-butyl hydroperoxide (5.47M; 67 ml, 0.36 mol), and salicyclic acid (1.42, 0.01 mol) to give the known alcohol (**24**) (9.55 g), along with the over-oxidized aldehyde product (2.92 g), isolated by column chromatography on silica (light petroleum–ether). Reduction of this aldehyde to the alcohol (**24**) was achieved using sodium borohydride (525 mg, 0.014 mol) and cerium(III) chloride (5.16 g, 0.014 mol) in methanol (35 ml). Acidification and extractive work-up of the reaction mixture gave the alcohol (**24**) (combined yield 11.85 g, 64%). To a solution of this alcohol (8.82 g, 0.0416 mol) and imidazole (6.22 g, 0.0915 mol) in dimethylformamide (17.6 ml) under nitrogen at room temperature was added t-butyldiphenylchlorosilane (11.9 ml, 12.58 g, 0.046 mol) and the reaction mixture was stirred for 18 h; it was then diluted with ether (700 ml), washed with water (3 × 300 ml) and brine (300 ml), dried ($MgSO_4$) and evaporated to give the crude silyloxy acetate. This was not purified at this stage but dissolved in ethanol (120 ml) and potassium carbonate (28.7 g, 0.21 mol) added to the solution. The mixture was then stirred vigorously at room temperature for 2 h, diluted with ether (1 000 ml), washed with brine (400 ml), and the brine re-extracted with ether (200 ml). The combined organic layers were then re-washed with brine (400 ml), dried ($MgSO_4$), and evaporated and the residue purified by column chromatography on silica (light petroleum–ethyl acetate) to yield the *title compound* (**25b**) (12.29 g, 72% over 2 steps) as a near colourless oil (Found: C, 76.3; H, 9.1. $C_{26}H_{36}O_2Si$ requires C, 76.4; H, 8.9%); $\nu_{max.}$(film) 3 334, 2 931, 2 857, 1 669, 1 590, 1 428, 1 112, 824, 741, and 703 cm^{-1}; δ_H(270 MHz; $CDCl_3$) 1.09 (9 H, s, Bu^t), 1.61 (3 H, s, 7-Me), 1.63 (1 H, s, 1-OH), 1.69 (3 H, s, 3-Me), 2.04—2.26 (4 H, m, 4-CH_2 and 5-CH_2), 4.07 (2 H, s, 8-CH_2), 4.15 (2 H, d, *J* 12.5 Hz, 1-CH_2), 5.40—5.50 (2 H, m, 2-CH and 6-CH), 7.35—7.45 and 7.66—7.75 (10 H, 2 m, ArH); *m/z* 390 ($M^+ - H_2O$), 351, 333, 283, and 199.

(2R,3R)-8-(*t-Butyldiphenylsilyloxy*)-2,3-*epoxy*-3,7-*dimethyl*-1-(4-*tolylsulphonyloxy*)*oct*-6-*ene* (**26b**).—To a stirred suspension of activated powdered 4 Å molecular sieves (2.0 g) in dry dichloromethane (90 ml) at −20 °C under nitrogen was added sequentially (−)-diethyl tartrate (0.31 ml, 374 mg, 1.83 mmol), titanium tetraisopropoxide (0.36 ml, 348 mg, 1.23 mol) and anhydrous t-butyl hydroperoxide in dichloromethane (5.38M; 6.83 ml, 36.8 mmol). The suspension was stirred for a further 0.25 h, cooled to −40 °C and a solution of the allylic alcohol (**25b**) (10.0 g, 24.5 mmol) in dry dichloromethane (10 ml) was added dropwise over a period of 0.25 h. The reaction mixture was stirred at −40—20 °C for 4 h, allowed to warm to room temperature, and then carefully concentrated to approximately half-volume. The reaction flask was re-flushed with nitrogen, cooled to −10 °C and triethylamine (3.75 ml, 2.72 g, 26.9 mmol) was added, followed by toluene-4-sulphonyl chloride (5.12 g, 26.9 mmol) and 4-dimethylaminopyridine (23 mg, 0.21 mmol) in dry dichloromethane (5 ml). The yellow suspension was stirred at 0—4 °C for 18 h, diluted with ether (250 ml), washed with water (100 ml) and brine (100 ml), dried ($MgSO_4$), and evaporated, and the residue purified by column chromatography on silica (light petroleum–ether) to give the *title compound* (**26b**) (7.23 g, 57% over 2 steps) as a near colourless oil, $[\alpha]_D^{25}$ +6.85° (*c* 2.00, CH_2Cl_2) (Found: C, 68.3; H, 7.5; S, 5.7. $C_{33}H_{42}O_5SSi$ requires C, 68.5; H, 7.3; S, 5.5%); $\nu_{max.}$(film) 2 932, 2 857, 1 602, 1 590, 1 428, 1 366, 1 190, and 704 cm^{-1}; δ_H(270 MHz; $CDCl_3$) 1.05 (9 H, s, Bu^t), 1.23 (3 H, s, 3-Me), 1.58 (3 H, s, 7-Me), 1.44—1.54 (1 H, m, 4-CH), 2.04—2.13 (2 H, m, 5-CH_2), 2.44 (3 H, s, ArMe), 2.98 (1 H, t, *J* 7 Hz, 2-CH), 4.03 (2 H, s, 8-CH_2), 4.05—4.10 (2 H, m, 1-CH_2), 5.31—5.42 (1 H, m, 6-CH), 7.30—7.48 and 7.5—7.85 (14 H, 2 m, ArH); *m/z* 596 ($M^+ + NH_4$, C.I.), 511, 377, 353, 293, 199, and 91.

(2R,3R)-8-(*t-Butyldiphenylsilyloxy*)-2,3-*epoxy*-1-*iodo*-3,7-*dimethyloct*-6-*ene* (**27b**).—To a refluxing solution of the epoxy tosylate (**26b**) (4.0 g, 6.92 mmol) in dry acetone (50 ml) under nitrogen with the exclusion of light was added sodium iodide (2.08 g, 13.8 mmol) in dry acetone (3 ml). After the solution had been heated for a further 2 h it was allowed to cool when it was diluted with ether (250 ml), washed with water (2 × 100 ml), aqueous sodium metabisulphite (10%; 100 ml), saturated aqueous sodium hydrogen carbonate (100 ml), water (100 ml), and brine (100 ml), dried ($MgSO_4$), and evaporated to give a yellow oil. This was purified by column chromatography on silica (light petroleum–ether to give the *title compound* (**27b**) (2.58 g, 70%) as a clear, colourless oil, $[\alpha]_D^{25}$ −3.3° (*c* 1.00, CH_2Cl_2) (Found: C, 58.5; H, 6.9; I, 23.9. $C_{26}H_{35}IO_2Si$ requires C, 58.4; H, 6.6; I, 23.7%); $\nu_{max.}$(film) 2 932, 2 857, 1 672, 1 590, 1 473, 1 428, 1 112, 702, and 615 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.07 (9 H, s, Bu^t), 1.29 (3 H, s, 3-Me), 1.41—1.55 (1 H, m, 4-CH), 1.63 (3 H, s, 7-Me), 1.69—1.79 (1 H, m, 4-CH), 2.10—2.20 (2 H, m, 5-CH_2), 2.95—3.15 (2 H, m, 1-CH_2), 3.30—3.38 (1 H, m, 2-CH), 4.04 (2 H, s, 8-CH_2), 5.44 (1 H, m, 6-CH), and 7.34—7.48 and 7.75—7.83 (10 H, 2 m, ArH).

(6R,7R)-*Methyl* 12-(*t-Butyldiphenylsiloxy*)-6,7-*epoxy*-7,11-*dimethyl*-3-*oxododec*-10-*enoate* (**28b**).—To a stirred suspension of sodium hydride (60% as a dispersion in oil; 495 mg, 12.3 mmol) in tetrahydrofuran (35 ml) at −10 °C under nitrogen was added 1,3-dimethyltetrahydropyrimid-2-one (DMPU) (1.49 ml, 1.57 g, 12.3 mmol) followed by methyl acetoacetate (1.3 ml, 1.43 g, 12.3 mmol). The mixture was stirred for 10 min after which butyl-lithium (1.4M; 8.8 ml, 12.3 mmol) was added and the whole cooled to −78 °C. Stirring was continued for a further 0.25 h, after which the yellow dianion solution was transferred *via* a catheter to a solution of the iodo epoxide (**27b**) (2.00 g, 3.75 mmol) in tetrahydrofuran (49 ml) at −78 °C. The solution was allowed to warm to 0 °C over a period of 4 h after which it was quenched with saturated aqueous ammonium chloride (100 ml), extracted with ether (300 ml), and the extract washed with water (3 × 100 ml) and brine (100 ml). The aqueous layers were re-extracted and the combined organic layers dried ($MgSO_4$), evaporated, and purified by column chromatography on silica (light petroleum–ether) to give (i) the *title compound* (**28b**) (1.188 g, 61%) as a near colourless oil, $[\alpha]_D^{25}$ +3.6° (*c* 1.00, CH_2Cl_2) (Found: C, 71.0; H, 8.3. $C_{31}H_{42}O_5Si$ requires C, 71.2; H, 8.1%); $\nu_{max.}$(film) 3 468, 1 750, 1 719, 1 682, 1 621, 1 590, 1 429, 1 245, 1 112, 824, and 724 cm^{-1}; δ_H(270 MHz, $CDCl_3$) 1.10 (9 H, s, Bu^t), 1.27 (3 H, s, 7-Me), 1.39—1.53 (1 H, m, 8-CH), 1.60 (3 H, s, 11-Me), 1.62—1.77 (2 H, m, 5-CH and 8-CH), 1.86—2.00 (1 H, m, 5-CH), 2.04—2.07 (2 H, m, 9-CH_2) 2.65—2.80 (3 H, m, 4-CH_2 and 6-CH), 3.45 (2 H, s, 2-CH_2), 3.73 (3 H, s, OMe), 4.05 (2 H, s, 12-CH_2), 5.35—5.44 (1 H, m, 10-CH), 7.32—7.45 and 7.64—7.70 (10 H, 2 m, ArH); *m/z* 465 ($M^+ - Bu^t$), 447, 309, 211, 199, 148, 177, and 85; and (ii) 8-(t-butyldiphenylsilyloxy)-3,7-dimethyloct-1,6-dien-3-ol (481 mg, 31%) as a colourless oil, $[\alpha]_D^{25}$ −1.7° (*c* 1.00, CH_2Cl_2) (Found: C, 76.4; H, 8.9. $C_{26}H_{36}O_2Si$ requires C, 76.4; H, 9.2%); $\nu_{max.}$(film) 3 468, 2 931, 2 858, 1 719, 1 620, 1 590, 1 428, 1 112, 824, and 741 cm^{-1}; δ_H(270 MHz; $CDCl_3$) 1.06 (9 H, s, Bu^t), 1.32 (3 H, s, 3-Me), 1.61 (3 H, s, 7-Me), 1.55—1.65 (3 H, m, 3-OH and 4-CH_2), 2.04—2.15 (2 H, m, 5-CH_2), 4.05 (2 H, s, 8-CH_2), 5.06—5.11 (1 H, dd, J_{cis} 12.5 Hz, J_{gem} 1 Hz, 1-CH), 5.21—5.27 (1 H, dd, J_{trans} 16 Hz, J_{gem} 1 Hz, 1-CH), 5.41—5.50 (1 H, m, 6-CH), 5.90—6.00 (1 H, dd, J_{trans} 15 Hz, J_{cis} 12.5 Hz, 2-CH), 7.34—7.48, and 7.76—7.72 (10

H, 2 m, ArH); *m/z* 351 (M^+ − Bu^t), 333, 283, 265, 255, 239, 199, and 135.

(6R,7S)-*Methyl* 12-(*t-Butyldiphenylsilyloxy*)-2-*diazo*-6,7-*dihydroxy*-7,11-*dimethyl*-3-*oxodec*-10-*enoate* (**29b**).—To a solution of the β-keto ester (**28b**) (1.18 g, 2.27 mmol) in dry acetonitrile (39 ml) at −10 °C under nitrogen was added a solution of toluene-4-sulphonyl azide (672 mg, 3.41 mmol) in dry acetonitrile (8 ml) followed by triethylamine (0.48 ml, 344 mg, 3.41 mmol). The solution was stirred at −10 °C for 1 h and then 0—4 °C for 12 h, diluted with ether (500 ml), washed with aqueous sodium hydroxide (5%; 200 ml), water (2 × 200 ml), and brine (200 ml), dried ($MgSO_4$) and evaporated to give the crude intermediate diazo epoxide as a yellow oil, $\nu_{max.}$(film) 2 931, 2 857, 2 138, 1 724, 1 658, 1 429, 1 375, 1 312, 1 112, 704, and 616 cm^{-1}; δ_H(270 MHz; $CDCl_3$) 1.14 (9 H, s, Bu^t), 1.28 (3 H, s, 7-Me), 1.40—1.52 (1 H, m, 8-CH_2), 1.60 (3 H, s, 11-Me), 1.62—1.70 (1 H, m, 8-CH), 1.77—1.99 (2 H, m, 5-CH_2), 2.05—2.18 (2 H, m, 9-CH_2), 2.80 (1 H, dd, *J* 8 Hz, *J* 3 Hz, 6-CH), 3.00 (2 H, t, *J* 8 Hz, 4-CH_2), 3.81 (3 H, s, OMe), 4.03 (2 H, s, 12-CH_2), 5.36—5.43 (1 H, m, 10-CH_2), 7.32—7.46, and 7.63—7.68 (10 H, 2 m, ArH).

The crude diazo epoxide was dissolved in tetrahydrofuran–water (3:1; 30 ml) and perchloric acid (6 drops) was added to the solution; it was then stirred at room temperature for 3 h. After this the reaction mixture was diluted with ether (750 ml), washed with water (3 × 300 ml) and brine (200 ml), dried ($MgSO_4$), and evaporated and the residue purified by column chromatography on silica (light petroleum–ether) to give the *title compound* (**29b**) (842 mg, 66% over 2 steps) as a very viscous yellow oil: $[\alpha]_D^{25}$ −0.4° (*c* 1.00, CH_2Cl_2) (Found: M^+, 481.2034. $C_{31}H_{42}N_2O_6Si$ − C_4H_9 − N_2 requires *M*,481.2046); $\nu_{max.}$(film) 3 443, 2 933, 2 857, 2 138, 1 724, 1 658, 1 590, 1 429, 1 314, and 704 cm^{-1}; δ_H(270 MHz; $CDCl_3$) 1.05 (9 H, s, Bu^t), 1.20 (3 H, s, 7-Me), 1.34—1.44 (1 H, m, 8-CH), 1.61 (3 H, s, 11-Me), 1.65—1.79 (2 H, m, 5-CH and 8-CH), 1.85—1.98 (1 H, m, 5-CH), 2.07 (1 H, br s, 7-OH), 2.10—2.22 (2 H, m, 9-CH_2), 2.81 (1 H, d, *J* 7 Hz, 6-OH), 3.07 (2 H, dt, *J* 3 Hz, *J* 8 Hz, 4-CH_2), 3.36—3.45 (1 H, m, 6-CH), 3.83 (3 H, s, OMe), 4.04 (2 H, s, 12-CH_2), 5.40—5.48 (1 H, m, 10-CH), 7.32—7.42 and 7.65—7.69 (10 H, 2 m, ArH); *m/z* 481 (M^+ − Bu^t − N_2), 463, 409, 199, 125, and 81.

(6R,7S)-*Methyl* 6-*Acetoxy*-12-(*t-butyldiphenylsilyloxy*)-2-*diazo*-7-*hydroxy*-7,11-*dimethyl*-3-*oxododec*-10-*enoate* (**30b**).—A solution of the diazo diol (**29b**) (47.3 mg, 84 μmol) in pyridine (0.25 ml) under nitrogen was treated with acetic anhydride (25 μl, 27 mg, 0.266 mmol) and the mixture stirred at room temperature for 18 h. It was then diluted with ether (25 ml), washed with water (10 ml), saturated aqueous copper sulphate (10 ml), saturated aqueous sodium hydrogen carbonate (10 ml), and brine (10 ml), dried ($MgSO_4$), and evaporated. The residue was purified by column chromatography on silica (light petroleum–ether) to give the *title compound* (**30b**) (47.1 mg, 92%) as a viscous yellow oil, $[\alpha]_D^{25}$ −3.4° (*c* 2.00, CH_2Cl_2) (Found: M^+, 523.2162. $C_{33}H_{44}N_2O_7Si$ − C_4H_9 − N_2 requires *M*,523.2150); $\nu_{max.}$(film) 3 494, 2 931, 2 857, 2 137, 1 728, 1 658, 1 590, 1 312, 1 113, and 704 cm^{-1}; δ_H(270 MHz; $CDCl_3$) 1.16 (9 H, s, Bu^t), 1.20 (3 H, s, 7-Me), 1.24—1.34 (1 H, m, 8-CH), 1.45—1.59 (1 H, m, 8-CH), 1.60 (3 H, s, 11-Me), 1.78—1.91 (2 H, m, 5-CH_2), 2.10 (3 H, s, OCOMe), 2.05—2.20 (3 H, m, 9-CH_2 and 7-OH), 2.75—3.05 (2 H, m, 4-CH_2), 3.81 (3 H, s, CO_2Me), 4.04 (2 H, 5, 12-CH_2), 4.90 (1 H, dd, *J* 15 Hz, *J* 5 Hz, 6-CH), 5.38—5.46 (1 H, m, 10-CH), 7.32—7.44 and 7.65—7.68 (10 H, 2 m, ArH); *m/z* 580 (M^+ − N_2), 537, 523, 241, and 199.

(6R,7S)-*Methyl* 6-*Acetoxy*-3-*t-butyldimethylsilyloxy*-7-[5-(*t-butyldiphenylsilyloxy*)-4-*methylpentyl*]-7-*methyl*-4,5,6,7-*tetrahydro-oxepine*-2-*carboxylate* (**32b**).—A suspension of rhodium acetate (0.9 mg, 0.002 mmol) in refluxing dry benzene (3.2 ml) was treated with the diazo alcohol (**30b**) (47.1 mg, 77 μmol) in dry benzene (3.1 ml), and heating continued for 0.5 h. On cooling, the reaction mixture was filtered through Celite, and the Celite washed with benzene (20 ml). The combined benzene solutions were evaporated to give the acetoxyoxepane (**31b**) (39.3 mg, 88%) as a highly viscous yellow oil which was not purified at this stage but dissolved in dry dichloromethane (0.3 ml) and treated with triethylamine (36 μl, 25 mg, 0.25 mmol) followed by t-butyldimethylsilyl trifluoromethanesulphonate (60 μl, 69 mg, 0.254 mmol) with stirring at room temperature under argon. After 18 h, the reaction mixture was diluted with ether (25 ml), washed with water (2 × 20 ml), saturated aqueous sodium hydrogen carbonate (few drops) in water (10 ml), and brine (10 ml), dried ($MgSO_4$), and evaporated. The residue was purified by column chromatography on silica (light petroleum–ether) to give the *title compound* (**32b**) (6.0 mg, 11%) as a clear colourless glass: $[\alpha]_D^{25}$, +6.5° (*c* 0.10, CH_2Cl_2) (Found: M^+, 637.3008. $C_{39}H_{58}O_7Si$ − C_4H_9 requires *M*, 637.3016); $\nu_{max.}$(CCl_4) 2 930, 2 858, 1 742, 1 718, 1 625, 1 320, 1 241, 1 114, 1 063, and 1 031 cm^{-1}; δ_H(500 MHz; $CDCl_3$) 0.20 (6 H, s, Me_2Si), 0.97 (9 H, s, *Bu*^{t}Me_2Si), 1.05 (9 H, s, *Bu*^{t}Ph_2Si), 1.20 (3 H, s, 7-Me), 1.62 (3 H, s, *Me*CCH), 1.64—1.80 (2 H, m, CH_2CH_2CMe), 1.86—1.95 (1 H, m, 5-CH), 1.98—2.04 (1 H, m, 5-CH), 2.06 (3 H, s, OCOMe), 2.12—2.27 (2 H, m, MeCCHCH_2), 2.39—2.48 (1 H, m, 4-CH), 2.66—2.75 (1 H, m, 4-CH), 3.71 (3 H, s, OMe), 4.04 (2 H, s, CH_2OSiPh_2Bu^t), 4.80 (1 H, dd, *J* 10 Hz, *J* 2.5 Hz, 6-CH), 5.40—5.45 (1 H, m, MeC*CH*), 7.33—7.43, and 7.65—7.72 (10 H, 2 m, ArH); *m/z* 693 (M^+ − H), 637, 471, 413, 322, 199, 135, and 75.

Acetonide Derivative of (6R,7S)-*Methyl* 12-(*t-Butyldiphenylsilyloxy*)-2-*diazo*-6,7-*dihydroxy*-7,11-*dimethyl*-3-*oxododec*-10-*enoate* (**33**).—A solution of the diol (**29b**) (38.1 mg, 67 μmol) in dry dichloromethane (0.25 ml) was treated with 2,2-dimethoxypropane (41 μl, 35 mg, 0.336 mmol) followed by toluene-*p*-sulphonic acid (1 mg, 58 μmol) with stirring at room temperature under nitrogen. After 4 h, the reaction mixture was diluted with dichloromethane (25 ml) washed with water 2 × 20 ml) and brine (20 ml), dried ($MgSO_4$), and evaporated. The residue was purified by column chromatography on neutral alumina (light petroleum–ether) to give the *title compound* (**33**) (12.3 mg, 33%) as a viscous pale yellow oil, +2.5° (*c* 1.00, CH_2Cl_2) (Found: M^+, 549.2421. $C_{34}H_{46}N_2O_6Si$ − C_4H_9 requires *M*, 549.2421); $\nu_{max.}$(film) 2 932, 2 857, 2 135, 1 728, 1 659, 1 590, 1 369, 1 312, 1 112, 824, and 704 cm^{-1}; δ_H(250 MHz; $CDCl_3$) 1.05 (9 H, s, Bu^t), 1.25 (3 H, s, 7-Me), 1.35 and 1.41 [6 H, 2 s, OC$(CH_3)_2$O], 1.49—1.62 (2 H, m, 8-CH_2), 1.60 (3 H, s, 11-Me), 1.76—1.80 (2 H, m, 9-CH_2) 2.02—2.15 and 2.16—2.22 (2 H, 2 m, 5-CH_2), 2.90—3.21 (2 H, m, 4-CH_2), 3.70—3.76 (1 H, m, 6-CH), 3.85 (3 H, s, OMe), 4.04 (2 H, s, 12-CH_2), 5.37—5.46 (1 H, m, 10-CH), 7.32—7.43, and 7.65—7.70 (10 H, 2 m, ArH); *m/z* 549 (M^+ − Bu^t), 521, 495, 311, 199, and 135.

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